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the Fish. Res. Lab.
Contributions

Contributions from the Department of Fisheries
and
the Fishery Research Laboratory, Kyushu University

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Foreword

After the Department of Fisheries and the attached Fishery Research Laboratory of Kyushu University were founded in 1941 and 1944, respectively, the research activities were greatly inhibited due to the outbreak of World War II and the restoration from its damage. After the War, activities were resumed and an increasing number of scientific papers have been published in various journals and bulletins.

It is, of course, difficult to obtain all of the available reports on the science of fisheries, particularly those which are carried out in Japan. This is perhaps one of the reasons why there are frequent duplication in and neglect of related works in this field.

It is hoped that this bulletin which is a compilation of all the scientific achievements from our institute will render our research works available to fisheries research organizations in foreign countries. The exchange of your scientific publications with this bulletin will be acknowledged with appreciation and will serve to promote the advancement of the science of fisheries in the whole world.

September, 1959

Department of Fisheries and
Fishery Research Laboratory,
Kyushu University,
Fukuoka, Japan

List of periodicals wherein published

Botanical Magazine, Tokyo	(植 物 学 雜 誌)
Breviora	
Bulletin of the Biogeographical Society of Japan	(日 本 生 物 地 理 学 会 々 報)
Bulletin of the Japanese Society of Scientific Fisheries	(日 本 水 産 学 会 誌)
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Japanese Journal of Ecology	(日 本 生 態 学 会 誌)
Japanese Journal of Ichthyology	(魚 類 学 雜 誌)
Japanese Journal of Limnology	(陸 水 学 雜 誌)
Journal of the Agricultural Chemical Society of Japan	(日 本 農 芸 化 学 会 誌)
Journal of the Faculty of Agriculture, Kyushu University	(九 大 農 学 部 紀 要)
Journal of Japanese Botany	(植 物 研 究 雜 誌)
Journal of the Oceanographical Society of Japan	
Kagaku	(科 学)
Nutrition and Food	
Proceedings of the Japan Academy	(日 本 学 士 院 紀 事)
Proceedings of the 7th Pacific Science Congress	
Publications of the Seto Marine Biological Laboratory	
Records of Oceanographic Works in Japan	
Research in the effects and influences of the Nuclear Bomb Test Explosions (Tokyo)	
Science Bulletin of the Faculty of Agriculture, Kyushu University	(九 大 農 学 部 学 芸 雜 誌)
Seibutsu	(生 物)

Contributions from the Department of Fisheries and the
Fishery Research Laboratory, Kyushu University. No. 3 (1957)

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and not included in this series.

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ミミズハゼの生活史

道 津 喜 衛

The life history of the goby, *Luciogobius
guttatus* Gill

Yosie Dôtu

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ミミズハゼの生活史¹⁾²⁾

道 津 喜 衛

The life history of the goby, *Luciogobius guttatus* Gill

Yosie Dôtu

は し が き

ミミズハゼ属およびその近縁種の分類については C. T. Regan(1905, '40), J. O. Snyder (1909), 富山一郎 (1936), 松原喜代松 (1955)³⁾の諸氏がそれぞれの見解にもとづいた研究を報告している。筆者は 1947 年以来, 神奈川県三浦市三崎, 高知県須崎市, および九州各地で多数のミミズハゼ *Luciogobius guttatus* Gill を採集し併せて棲息場における習性の観察を行い生活史の大要を知ることが出来たのでここに報告する。

はじめにこの研究を行うに当り懇切なる御指導と原稿の御校閲をいただいた 内田恵太郎教授に深謝すると共に文献, 標本の閲覧について御教示と御便宜をいただいた 京都大学水産学科の松原喜代松教授, 東京大学三崎臨海実験所長 富山一郎博士, 水産庁東海区水産研究所の阿部宗明博士の諸氏に厚くお礼申し上げる。

成 魚 の 形 態 (Fig. 1)

D. S. Jordan and J. O. Snyder (1902), 富山一郎 (1936) などの諸氏がすでに報告し

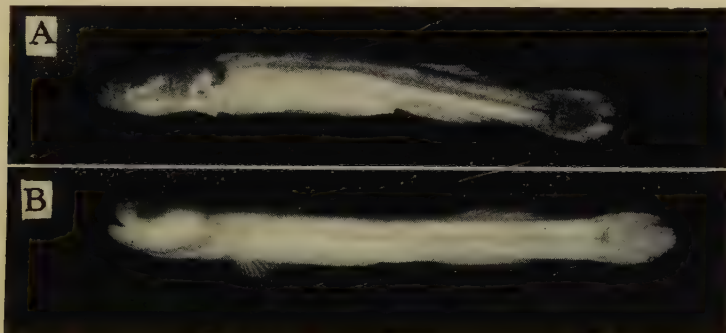


Fig. 1. *Luciogobius guttatus* Gill

A: Mature female, 39 mm in total length. B: Mature male, 43 mm.

- 1) 九州大学農学部水産学教室業績。この論文の内容の一部はすでに日本水産学会中国支部大会において講演発表した。1950年11月4日。於下関市。
- 2) この研究の一部はユネスコ海洋資源開発調査研究費によつて行つた。ここに記して関係当局に感謝の意を表する (内田恵太郎)。
- 3) この論文中のハゼ類の種名はすべて松原喜代松 (1955) に従つた。

ているようにミミズハゼの外部諸形質の個体差は著しい。九州各地から得た成魚標本(全長 32~70 mm) 37 尾についての測定によると背鰭 I+10~13. 臀鰭 I+11~14. 胸鰭 17~18. 右第 1 鰓弓の鰓耙数 17~18. 脊椎骨数 35~38.

二次性徴は生殖孔突起の形状差として現われる。しかしその差は著しくなく産卵期の雌成魚の突起は太く膨れ、雄成魚の突起は細く小さいのでその差によつて性の判別が容易に出来るが産卵期以外の時季の成魚および未成魚では突起の差は少くそれによる性の判別は困難である。

体色の個体差は著しく、同じ棲息場から同時に採集した標本についてみても、個体によつて淡黒色から黒褐色までの種々の体色状態を示す。この著しい体色の個体変異を起す要因については明かにすることが出来なかつた。

一般習性および産卵習性 (Fig. 2~4)

ミミズハゼは日本各地、朝鮮、北支那などの各地に広く分布していることが知られている。

九州各地および神奈川県三崎において干潮時に観察したところ、ミミズハゼは川口の瀕水域および淡水の影響を強く受ける海岸の潮間帯に横たわる小石の下に潜んで棲んでいた。

産卵期は天然卵を採集出来た期間からみて福岡市およびその近郊では 1 月下旬から 5 月上旬までの長期に亘るようである。

宮崎県大淀川々口では 2 月 11 日 (1951 年) に全長 19~22 mm の仔魚が多数採集され、高知県須崎市沿岸では 11 月 (1951, '53, '54 の各年) に全長 8~9 mm のミミズハゼと同定される多数の仔魚がイワシラス船曳網〔須崎市ではこの網を瓢曳網(ひょうびきあみ)と呼んでいる〕によつてカタクチイワシ仔魚に混つて獲れている。これらの結果からみると各地のミミズハゼの産卵期を正確に知ることは容易でないようである。

卵巢内卵数は全長 33~70 mm の成熟魚 14 尾について 360~1,671 個を計えた。また成熟個体の卵巢内の熟卵はほぼ等しい卵径を示した (Table 1)。

産卵場は棲息場の中にあり、産卵期には多数の成魚が棲息場の内の限られた狭い産卵適地と思われる場所に集まる傾向があることに気付いたが個体標識法による産卵期の親魚の移動と集中の状態、普段の棲息習性と産卵習性との関連性などについての詳しい調査は行っていない。

産卵場は満潮時の水深が 3 m 以下のところであり、底質は砂泥或は細礫よりなり、水底に多数の石が横たわつていた。ミミズハゼはこれらの石の中で底面が平たく下部が僅かに砂泥或は細礫に埋れているものを選びその中央部下に産卵室を設けていた⁴⁾。

産卵室は石の下面を天井としその下の砂泥底表面に造られた小凹部であり、室の広さは親魚 1 尾がその中で自由に動き廻りうる程度であつた。産卵室として利用されていた石は底面積が小は 10 cm×10 cm, 大は 30 cm×30 cm の種々の大きさのものであつた。

産卵室から外部に通ずる通路の痕跡と思われる不明瞭な小溝を石の下の砂泥表面に認め

4) 福岡市室見川々口の瀕水域においては毎年 4~5 月 (1954~'56 年の各年に観察) に同じ水域でミミズハゼとシロウオ *Leucopsarion petersi* Hilgendorf の産卵が同時に多数見られた。

Table 1. Number of the ovarian eggs

No. of specimen	Total length in mm	Body length in mm	Number of the ovarian eggs		
			Right ovary	Left ovary	Total
1	33	28	199	161	360
2	37	31	263	265	528
3	39	34	—	—	447
4	40	34	258	200	458
5	40	36	—	—	510
6	42	36	416	363	779
7	44	37	312	322	634
8	45	40	—	—	849
9	49	42	392	335	727
10	52	43	477	548	1,025
11	59	52	597	592	1,189
12	62	54	557	787	1,344
13	67	59	811	860	1,671
14	70	62	707	743	1,450

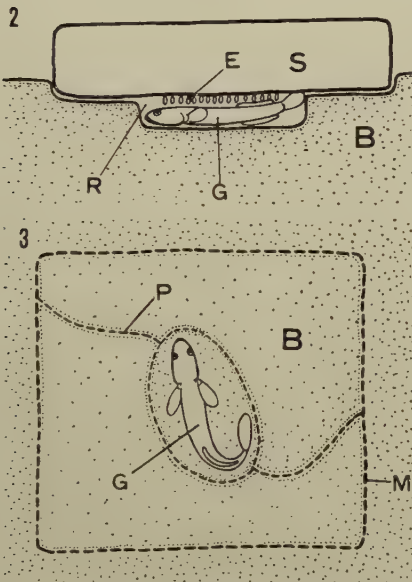


Fig. 2. Diagrammatic cross section view of the breeding room.

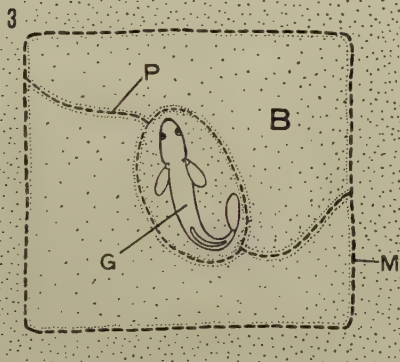


Fig. 3. Diagrammatic horizontal view of the breeding room, covering stone removed.

B, Sandy mud bottom deposit.

E, Eggs attached to the under side of stone.

G, Male parent fish, guarding the spawned eggs.

M, Marginal line of removed stone.

P, Trace of the path, connecting the breeding room with outside.

R, Breeding room.

得たのは調査した産卵室四十余例のうちの二、三にすぎず他の例ではそれすら認めることが出来なかった。

卵は石の下面に一層に密な群をなして産み附けられ垂れ下っていた。卵群の占める面積は円形或は楕円形をなすものが多く、1卵群の卵数は小さな卵群の部に入る直径約3.5 cmの円形卵群では960個、2 cm×4.5 cmの矩形卵群で784個を数えた。観察した卵群二十余例について、同一卵群中の各卵の卵発生の段階はほぼ等しかつた。

上に述べた卵巣内卵数 (Table 1), 卵巣内卵の卵径, 附着卵数, 附着卵の卵発生の段階

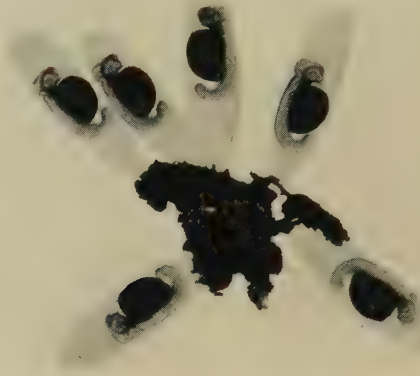


Fig. 4. Spawned eggs (X 9) removed from the stone.

などの諸点を考え合せると同一卵群の全卵は1尾の雌親魚によつて同時に産卵されたものと考えられる。しかし雌、雄の成魚がそれぞれ一産卵期に何回産卵に与るかは不明である。

雌親魚は産卵が済むとすぐに産卵室を去るようであるが、雄親魚は1尾だけで卵が孵化するまで室内に留つていた。

上に述べたミミズハゼの産卵室は例えばアゴハゼ *Chasmichthys dolichognathus* (Hilgendorf), チチブ *Tridentiger obscurus* (Temminck et Schlegel), ウロハゼ *Glossogobius giurinus brunneus* (Temminck et Schlegel) などの既知のハゼ類の産卵のように単に水底に横たわる石の下の間隙や貝空殻内面の凹部を利用してそこに卵を産みつけるものではなく、親魚が積極的に石の下面を利用してその下の砂泥表面に産卵室を造つて産卵したものであり、この産卵室の形状はムツゴロウ *Bolcophthalmus chinensis* (Osbeck), ハゼクチ *Synechogobius hasta* (Temminck et Schlegel), ヒモハゼ *Eutaeniichthys gilli* Jordan et Snyder などのハゼ類の産卵室について知られている縦孔型の産卵室とも異つた横孔型のものであり、ハゼ類産卵室の一型を代表するものであると著者は考えている。しかし大部分の産卵室では外部に通ずる通路を認め得なかつたこと、および産卵室を造る行動についての詳しい観察がないことが新しい横孔型の産卵室を考えるうえに問題点として残る。

ミミズハゼの体がウナギ状に細長く、頭部は著しく縦扁していることは上に考えた産卵期の掘孔習性と関聯があるのかも知れないが数年間に亘る棲息場での観察によるとミミズハゼは水底に横たわる石や礫の下の間隙に逃げ隠れる行動は示したが、掘孔習性は示さなかつた⁵⁾。

福岡市近郊で採集した成魚の消化管内容物はゴカイ類、等脚類などの小動物であつた。

5) シロウオも体は細長く頭部は縦扁したハゼ類の一種であるが、その産卵習性については当教室の大学院学生庄島洋一氏が産卵期のシロウオ成魚を採集して、流水装置のついた室内淡水々槽で飼育し産卵させた時に(1956年5月)雄親魚が石の下に潜り石の下の砂粒を口にくわえて外に運び出し、産卵室を設ける行動を詳しく観察している。同氏の同意を得たのでここに引用する。

卵 内 発 生 (Fig. 5)

受精卵は長径 2.5 mm, 短径 0.7 mm の長なす形, 卵膜先端は円く, 先端近くに浅いくびれがある。卵膜後部は次第に細くなり, 後端に附着絲叢がある。卵発生の各段階については他のヘゼ類のそれらと較べて特に記す点はない。孵化前になると胚体は卵膜内で折れ曲がり, 胚体運動は盛んになり, 卵膜先端部に位置する胚頭上部に多数の顆粒状の孵化酵素腺が現われ, 卵膜先端に孵出孔が開く (Fig. 5, E)。孵化時間は水温 15~20°C で約 10 日間を要した。

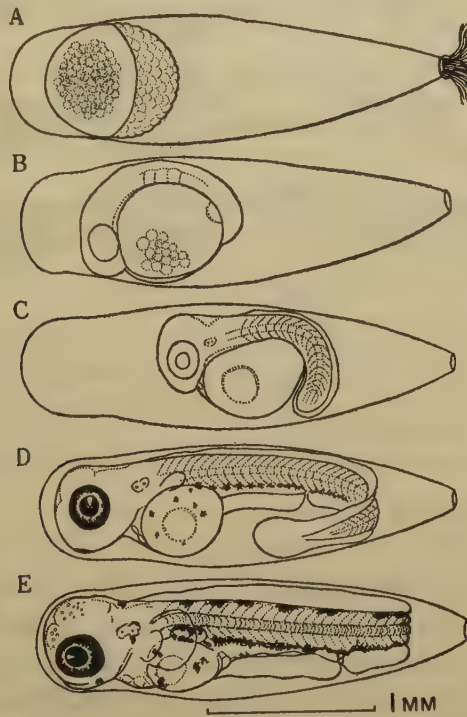


Fig. 5. Developing eggs

A, Morula stage. B, 3 myotome stage, Kupffer's vesicle and eye-balls formed in the embryonal body. C, 17 myotome stage, optic lenses and otocysts formed. D, 7 days old embryo. E, 10 days old embryo, just before hatching.

Bundles of adhesive filaments at the basal end of B, C, D, and E, omitted.

二十余例の卵群についての観察によると, 同一卵群中の各卵の卵黄の色は同じ色を示し黄色が多かつたが少数の卵群では淡黄色或は橙黄色を示すものもあつた。

仔魚および稚魚 (Fig. 6)

孵化直後の仔魚は全長 3.5 mm (Fig. 6, A), 体の背腹両正中線にそれぞれ縦に並ぶ大きな黒色胞群がありこの仔魚の一特徴をなす。体側筋肉数 $17+18=35$ 。背側の仔魚鰭膜先端は後頭部に始まる。

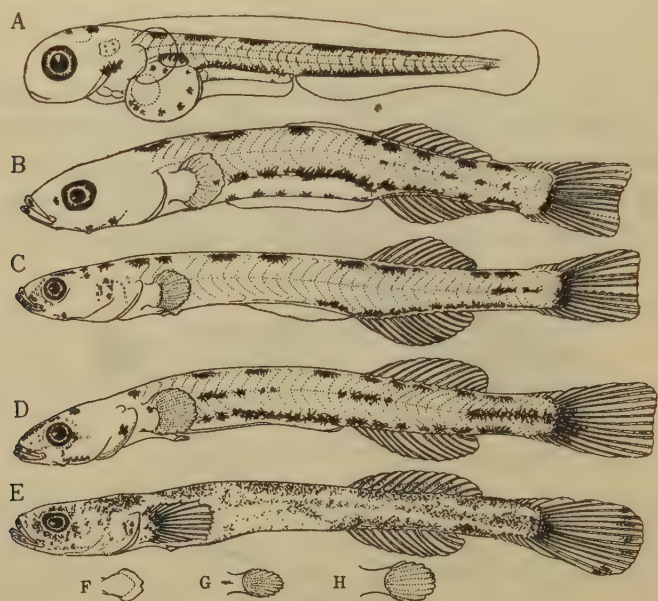


Fig. 6. Larvae, juvenile, and their ventral fins.

A, Newly hatched larva, 3.5 mm in total length. B, Postlarva, 8.5 mm. C, Postlarva, 14.2 mm. D, Postlarva, 17.0 mm. E, Juvenile, 18.0 mm. F, Ventral fin of B. G, Ventral fin of C. H, Ventral fin of D.

A drawn from alive specimen, B~H from preserved specimens.

全長 7.0 mm 以下の後期仔魚はまだ採集されていない。

全長 8.5 mm (Fig. 6, B: 以下の仔, 稚魚の記載はすべてフオルマリン固定, アルコール保存の標本によつた) の稚魚は体は側扁し, 体長は体高の 7.5 倍, 頭長の 3.7 倍, 頭胴長の 1.5 倍。尾柄長は尾柄高に等しく, 背, 臀鰭はそれぞれ 11, 13 軟条となり定数に達する。腹部および尾柄部の体縁にはなお仔魚鰭膜が残る。腹鰭は基底後縁に薄い鰭膜がのびその後端に小欠刻がある (Fig. 6, F)。黒色胞叢は背, 腹両正中線, 体側中央部, 消化管上にそれぞれ一縦列に断続して並びこの他に頭部および尾鰭基底部にも現われている。

全長 14.2 mm (Fig. 6, C) の仔魚は体は伸び, 側扁度は減つている。腹部の腹側体縁部にはなお仔魚鰭膜が残る。黒色胞は背, 腹両正中線および尾部の体側中央部にそれぞれ一縦列に断続して並び, 消化管上の黒色胞数は上記の 8.5 mm の仔魚より少くなつている。

全長 17.0 mm (Fig. 6, D)。体側の黒色胞は数を増し, 仔魚鰭膜は消えて見られない。胸鰭はウチワ状をなし鰭条原基が認められる。腹鰭は小さく円形, 鰭条数は定数となり $I + 5$ (Fig. 6, H)。尾鰭後縁は截形。

全長 18.0 mm (Fig. 6, E) の稚魚は体形は成魚に似ており, 胸鰭は矩形, 尾鰭後縁は半円形。体側の黒色胞は数を増し体表面全体に拡がついて体色は淡黄褐色を帯びる。

全長 7.0 mm ~ 22.0 mm の仔魚は九州各地の採集によると例年 3 ~ 5 月の間に沿岸のイワシシラス網 (船曳網および地曳網) によつてイワシ類仔魚に混つて多数獲れた。このシラス網の漁法からみてこれらの ミミズハゼの仔魚は海岸汀線からやや離れた沿岸水域の

中層で游泳生活を送っていると思われる。なおこれら仔魚の消化管内容物は浮游性橈脚類であつた。

全長 15 mm を越える稚魚は川口や内湾の潮間帯で成魚と同じ底棲生活を始めていた。

底棲生活を始める時の仔魚の大きさを知るためシラス網で獲れた游泳生活末期の仔魚と潮間帯で採集した底棲生活初期の稚魚との全長を比較した結果は (Table 2) に示す通りである。この結果はミミズハゼの仔魚が游泳生活から底棲生活に移る生態の変化時に形態的には全長の縮少が起ることによるか、または底棲生活を始める時期の仔魚の全長には著しい個体差があるためによるか、そのいずれの場合も考えられるが、この点については適当な仔魚個体識別法を考えた上で飼育実験によつて確める必要がある。なお游泳生活を送る仔魚期はミミズハゼの全生活史のうちで最も種の散布に適した時期であると考えられるが仔魚の移動範囲その他については不明である。

Table 2. Measurements of larvae in the last swimming life and juveniles in the early bottom life

Total length in mm	Number of the larvae	Number of the juveniles	Total length in mm	Number of the larvae	Number of the juveniles
15.1—15.5	0	1	19.0—19.5	4	2
15.5—16.0	0	0	19.5—20.0	2	3
16.0—16.5	1	3	20.0—20.5	1	3
16.5—17.0	2	0	20.5—21.0	0	1
17.0—17.5	1	3	21.0—21.5	1	0
17.5—18.0	2	3	21.5—22.0	0	0
18.0—18.5	2	2	22.0—22.5	1	0
18.5—19.0	1	5			
Total				18	26

成 長

成長度調査のため特に計画的に集めた材料ではないが稚魚から成魚までの大、小約 400 尾の採集標本について上に述べた生態、生活史を考えに入れて全長組成を調べた結果から、福岡市附近のミミズハゼは生後満 1 年で全長 30～48 mm となり、その一部は成魚となり産卵に与ること：満 2 年で全長 48～63 mm：3 年で 63 mm を越えることが予報的に言い得る。なお調査標本のうちの最小成体は雌、雄ともに全長 33 mm。最大魚は雌 70 mm、雄 75 mm であつた。

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R é s u m é

Luciogobius guttatus Gill is a small, elongate yellowish goby, living under the stones lying on the estuarine muddy sand beach. It is distributed widely in North China, Korea, and Japan (Fig. 1).

As is already reported by D. S. Jordan and J. O. Snyder (1901) and I. Tomiyama (1936), this fish shows remarkable individual variety in the body form, coloration, and number of fin-rays as well as vertebrae.

The spawning season extends from January to May in the vicinity of Fukuoka City, Kyushu. The number of ovarian eggs of one female fish were enumerated from 360 to 1,671 (Table 1). The breeding room is constructed as flat burrow under the stone where the parent fish live (Fig. 2 and Fig. 3). The female parent fish deposits eggs on the under side of the stone roof, the eggs hanging down from the stone in one layer mass. The number of the eggs of one sheet were enumerated 784 and 960 in two cases. When the spawning act finish the female parent fish leaves the breeding room, while the male parent guards over the eggs until they hatch.

The spawned egg is club shaped, measuring 2.5 mm in long axis and 0.7 mm in short axis, with a shallow depression encircling near the top of egg and a bundle of adhesive filaments at the basal end (Fig. 4).

The incubation-period lasted about 10 days at the temperature from 15°C to 20°C (Fig. 5).

The newly hatched larva was 3.5 mm in total length. The larvae, 7~22 mm (Fig. 6), in total length, were found swimming in the middle of the water near shore, feeding on planktonic copepods. When the larvae attained over 15mm in total length, they approach the beach and enter into the bottom life there (Table 2).

The specimens collected from Kyushu show that the goby grow to 30~48 mm in total length in a year, 48~63 mm in two years, and over 63 mm in three years. Some individuals seems to become mature in a year at 33 mm in total length in both sexes.

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Y. DOTU

A new species of a goby with a synopsis of the
species of the genus *Luciogobius* Gill and
its allied genera

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A new species of a goby with a synopsis of the species of the
Genus *Luciogobius* Gill and its two allied genera^{1,2}

YOSIE DÔTU

The author collected over one hundred specimens of a gobioid fish on the coasts of the Amakusa Islands, Kumamoto Prefecture, and the Tusima Islands, Nagasaki Pref. both in Kyūshū, which seemed to belong to the Genus *Luciogobius* Gill, and to be new to Science.

In this paper is given an account of the new species above mentioned with a synopsis of seven species of gobies belonging to the Genus *Luciogobius* Gill and its allied genera, *Inu* Snyder and *Expedio* Snyder.

Before going further, the author wishes to express his gratitude to Prof. Keitaro Uchida for his kind guidance and advice in this research and the preparation of this paper. Acknowledgements are also due to Dr. Ichiro Tomiyama and Dr. Tokiharu Abe who kindly offered facilities for consulting important literature and for the reexamination of the related specimens preserved in the Faculty of Science of Tokyo University: to Prof. Kiyomatsu Matsubara for facilities for consulting important literature: to Mr. Hiromu Ohashi and Mr. Satoshi Mito for their kind assistance in collecting specimens: and to Mr. Yoichi Syojima in the preparation of photographs.

Genus *Inu* Snyder

Inu koma Snyder

Snyder, J. O. 1909; Koumans, F. P. 1931; Matsubara, K. 1955.

¹) Contribution from Fisheries Laboratory, Faculty of Agriculture, Kyūshū University.

²) A part of this research is owing to the Aid for Fundamental Scientific Research of the Ministry of Education. (Keitaro Uchida)

Genus *Luciogobius* Gill*Luciogobius guttatus* Gill

Gill, T. 1859; Günther, A. 1861; Jordan, D. S. and Snyder, J. O. 1901;

Regan, C. T. 1905; Koumans, F. P. 1931; Tomiyama, I. 1936; Regan, C. T. 1940; Matsubara, K. 1955.

Genus *Expedio* Snyder*Expedio parvulus* Snyder

Snyder, J. O. 1909; Matsubara, K. 1955.

Key to the seven species belonging to three allied genera

- A. Ventral fin present
- B. Posterior part of body scarly—Genus *Inu* Snyder
- C. No. dermal ridge on head*Inu ama* Snyder
- CC. Dermal ridge on head*Inu koma* Snyder
- BB. Scale absent—Genus *Luciogobius* Gill
- D. Ventral fin moderate
- E. Eye normally developed, numerous dark spots on body
- F. Fleshy barbels under eye.....*Luciogobius saikaiensis* n. sp.
- FF. No. fleshy barbel under eye.....*Luciogobius guttatus* Gill
- EE. Eye reduced, not or slightly pigmented
.....*Luciogobius albus* Regan
- DD. Ventral fin a small flap.....*Luciogobius elongatus* Regan
- AA. Ventral fin absent—Genus *Expedio* Snyder
-*Expedio parvulus* Snyder

Table 1. Measurements of the seven species of the three genera.

Specific name	Head in length	Depth in length	Dorsal fin rays	Anal fin rays	Pectoral fin rays	Vertebrae*
<i>Inu ama</i> Snyder	3.3	5.6	9	10	—	—
<i>Inu koma</i> Snyder	3.4~4.0	6.0~7.5	11~12	10~11	17~20	30~31
<i>Luciogobius saikaiensis</i> n. sp.	3.5~4.0	8.0~9.5	8~10	9~10	18	32
<i>L. guttatus</i> Gill	4.5~6.0	6.5~10.5	11~15	8~10	17~18	35~38
<i>L. albus</i> Regan	3.5~5.5	8.0~13.0	10~11	10~12	12~14	31~34
<i>L. elongatus</i> Regan	7.0~8.0	10.0~12.0	7~9	8~10	12	42
<i>Expedio parvulus</i> Snyder	5.5~6.5	11.0~15.0	9~10	11~12	12~13	42~44

* counted on the X-ray photographs.

Inu ama Snyder

(Japanese name, Ama-haze)

Snyder, J. O. 1909; Matsubara, K. 1955,

Synonym—*Luciogobius guttatus ama* (Snyder), Tomiyama, I. 1936.

Locality—Misaki, Kanagawa Pref. (Snyder, J. O. 1909); Sirahama, Tiba Pref. (Sakamoto, K. 1932).

No. specimen was examined in this study.

***Inu koma* Snyder**

(Japanese name, Koma-haze)

Snyder, J. O. 1909; Matsubara, K. 1955.

Synonym—*Luciogobius guttatus koma* (Snyder), Tomiyama, I. 1936.

Locality—Misaki, Kanagawa Pref.; Oosima, Tokyo Capt.; Simoda, Sizuoka Pref. (Tomiyama, I. 1936); Kominato, Tiba Pref. (The author's collection); Fusan, Korea (Mori, T. 1952).

Eighteen specimens, 12~40 mm in total length, were examined in this study. Some of them had been studied by I. Tomiyama (1936).

The life history and bionomics will be reported in another paper.

***Luciogobius saikaiensis* n. sp. (Fig. 1 and Plate 2)**

(Japanese name, Hige-mimizu-haze)

Head 3.5 in standard length, depth 8.3, depth of caudal peduncle 11, length of caudal peduncle 5; eye 8 in head, snout 4, interorbital space 5.4, width of head 1.4; width of body 1.2 in depth; dorsal 10; anal 10; pectoral 18. Vertebrae 32.

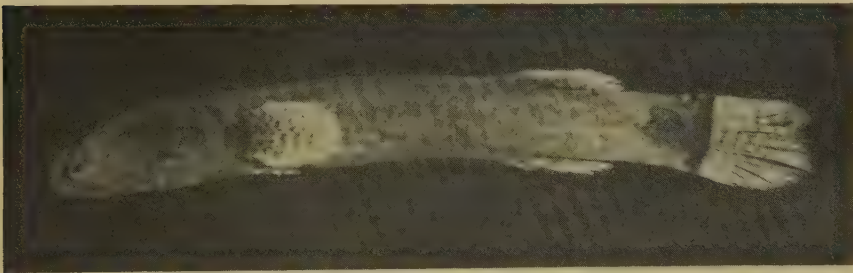


Fig. 1. *Luciogobius saikaiensis* n. sp.

Male adult, 35 mm in total length, one of the paratype specimens.

Body cylindrical anteriorly and moderately compressed posteriorly. Head broader than the body and considerably depressed, and muscles of side and top of head greatly bulging, thus forming a deep trough behind eye on the occiput. Interorbital space broad, slightly concave with narrow transverse fleshy ridge. Maxillary extending backward to a point beneath posterior part of eye. Mouth-cleft almost vertical anteriorly, but horizontal posteriorly. Teeth very small, arranged in

narrow bands on both jaws, outmost ones enlarged. Tongue broad, deeply notched and free anteriorly. Gill-cleft restricted to the side. Five fleshy barbels below eye, and a large one in front of eye. A pair of barbels at the snout. Nasal canal tubular, posterior one near eye. A ridge with a row of large sensory organs across the snout and along the side of head backward to below eye. A similar organ on the lower jaw, cheek, and occiput. Head and body wholly naked. Spinous dorsal absent. A slight median depression on the back before the dorsal with a row of minute plicae on its sides, those plicae being preceded by a slight, median ridge. Dorsal and anal opposite, inserted midway between bases of ventral and caudal; base of dorsal short and subequal to anal, both lengths about 2 in head. Dorsal somewhat higher than anal, both fins never reaching to the base of caudal when depressed. Membranes of dorsal and anal fleshy. Caudal rounded, 1.5 in head. Pectoral rounded, slightly pigmented, with 18 rays, the uppermost and lowest rays free and serrated. Ventral I, 5; anterior part thickened, posterior part with weak rays and fleshy membrane, and free posteriorly. A small genital papilla closely behind anus.

Color in spirit blackish, ventrally and caudad with white spots, vertical fins whitish with dark stripes across fin rays.

Holotypes—41 mm in total length, 35 mm in standard length male adult; from the sea-shore of Tomioka, the Amakusa Islands, Kumamoto Pref., Kyūshū.

Paratypes—Over 140 specimens, 5~41 mm in total length; from the sea-shores of Tomioka and Tuzizima, both in the Amakusa Islands, and Sasuna and Hidakatu, both in the Tusima Islands, Nagasaki Pref.

The type specimens are deposited in the Fisheries Laboratory, Faculty of Agriculture, Kyūshū University.

The life history and bionomics of this species will be reported in another paper.

(*Saikaiensis* means from West Sea District of Japan.)

Luciogobius guttatus Gill

(Japanese name, Mimizu-haze)

Gill, T. 1859; Günther, A. 1861; Jordan, D. S. and Snyder, J. O. 1901; Tomiyama, I. 1936; Regan, C. T. 1940; Matsubara, K. 1955.

Synonym—*Luciogobius guttatus guttatus* Gill (part), Tomiyama, I. 1936.

Locality—Japan throughout, Korea, and North China.

Over one thousand specimen, 7~72 mm in total length, from sea-shores of various districts of Japan, were examined in this study.

The life history and bionomics were reported in another paper (Dôtu, Y. 1957).

Luciogobius albus Regan³

(Japanese name, Dôkutu-mimizu-haze)

Regan, C. T. 1940; Matsubara, K. 1955.

Synonym—*Luciogobius guttatus guttatus* Gill (part), Tomiyama, I. 1936.*Luciogobius pallidus* Regan, Regan, C. T. 1940.

Locality—Daikoniza, Shimane Pref., from a subterranean cave and wells; Gobô, Wakayama Pref., from wells; Uwazima City, Ehime Pref., from a well; Misaki, Kôti Pref. from a well (Tomiyama, I. 1936).

Head 4 in length; depth 9; depth of caudal peduncle 12; D. 10; A. 10; P. 13, V. I, 5; Vertebrae 32.

Body cylindrical anteriorly, caudal peduncle moderately compressed. Head depressed. Eyes vestigial beneath skin. Tactile organs of head not so highly developed as the North American Blind Goby, *Typhlogobius californensis* Steindachner (Hubbs, C. L. 1927) and *Lethops connectens* Hubbs (Hubbs, C. L. 1920). Mouth large, teeth minute, in narrow bands on both jaws. Head and body naked, anterior nostril with a short tube. No barbel. All fins large. Anal fin inserted directly below the second ray of the dorsal. Dorsal fin higher than depth. Anterior fraenum of ventral making a deep pocket. No free ray in pectoral fin. Color in spirit yellowish white, unpigmented.

Holotype—43 mm in total length, 37 mm in standard length, from Daikonzima. Preserved in the Faculty of Science, Tokyo University. Specimen No. 25,693.

Paratypes—Thirteen specimens, 27~87 mm in total length, from above mentioned various localities. All the specimens are deposited in the Faculty of Science, Tokyo University.

I. Tomiyama (1936) figured two individuals of this goby as the blind forms of *Luciogobius guttatus guttatus* Gill. From the Tomiyama figures, C. T. Regan (1940) erected two new species, *Luciogobius pallidus* and *Luciogobius albus* separate from *Luciogobius guttatus* Gill.⁴ In

³) The author kept alive one of these blind gobies for 24 days, from 28th August, 1952, to 20th September. The goby was obtained in the cave in Daikonzima, Simane Pref., on 21st August, 1952. It was kept in a glass-jar at the laboratory, but was lost by careless management. During the period kept the water-temperature was from 22°C to 24°C, while at the natural habitat the temperature was 11.5°C. During that period the goby took no food, and became thinner day by day. It was about 55 mm in total length, and light pink in color. Generally no dark pigment appeared on the body, excepting a little which occasionally appeared on the posterior part of the body. From the observations upon the alive goby, it was supposed that the individual variation of body-form observed in the preserved specimens largely depended on the duration of the keeping-period after they were caught and the variation of pigmentation of body depended on the condition of pigmentation when they were thrown in the preservative.

⁴) K. Matsubara (1955) accepted Regan's two species, *Luciogobius pallidus* Regan (Japanese name, Ido-mimizu-haze) and *Luciogobius albus* Regan (Japanese name, Dôkutu-mimizu-haze).

this study, the author reexamined fourteen specimens, which had been studied by I. Tomiyama (1936). The examined specimens exhibited remarkable individual variation of body-form in proportion of head and body-depth to length, pigmentation, forms of dorsal, ventral, anal and pectoral fins, etc. (Table 1). C. T. Regan (1940) regarded these differences as the specific characteristics. But these differences appeared in each specimen in various degrees, so that the author could not recognize two separate species in those specimens as Regan did. From the reexamination of the preserved specimens and the observation of the above-mentioned alive fish (Foot Note 3), he came to the opinion that all these specimens belong to a single quite polymorphic, albinous *Luciogobius albus* Regan separate from *Luciogobius guttatus* Gill.

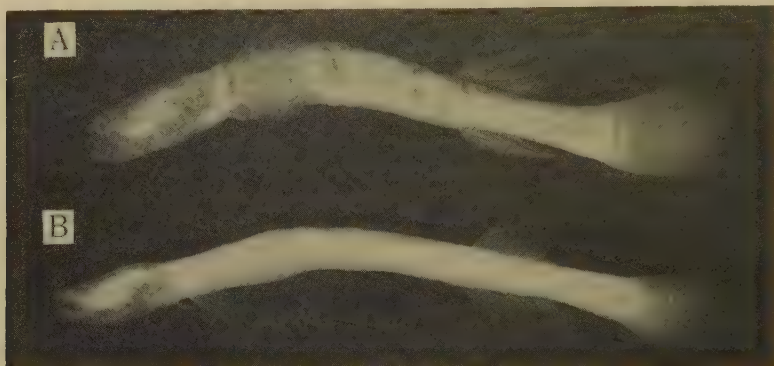


Fig. 2. *Luciogobius albus* Regan.

A, holotype, 43 mm in total length. B, one of the paratypes, 44 mm from Misaki, Kôti Pref.

Tomiyama's figures (1936) were drawn from these specimens, A and B. C.

T. Regan (1940) erected *Luciogobius albus* from the figure of A and *L. pallidus* from the figure of B respectively.

B is damaged in anal, dorsal, and ventral fins.

Luciogobius elongatus Regan (Fig. 3)

(Japanese name, Naga-mimizu-haze)

Regan, C. T. 1905, 1940; Matsubara, K. 1955.

Synonym—*Luciogobius guttatus guttatus* Gill (part), Tomiyama, I. 1936.

Locality—Seto Inland Sea (Regan, C. T. 1905); Tanegasima, Kagosima Pref. (Snyder, J. O. 1912); Matugaura, Kagosima Pref. (The author also collected from Kagosima Pref.).

N. Kuroda (1953) recorded this goby as coming from Lake Biwa, the largest fresh-water lake in Japan, Siga Pref. But it seems to be erroneous as this goby has so far been collected only from the sea-shore.

C. T. Regan gave no figure of this species in his papers. The figure given here from a specimen, collected from Matugaura, is the first one published (Fig. 3).

Only one specimen, collected from a tide pool on the coast of Matugaura, was examined in this study.



Fig. 3. *Luciogobius elongatus* Regan.
40 mm in total length.

Expedio parvulus Snyder

(Japanese name, Nansen-haze)

Snyder, J. O. 1909; Matsubara, K. 1955.

Synonym—*Luciogobius guttatus parvulus* (Snyder), Tomiyama, I. 1936.

Locality—Misaki, Kanagawa Pref. (Snyder, J. O. 1909); Sirahana, Tiba Pref. (Sakamoto, K. 1932).

Three specimens, 37~48 mm in total length, were examined in this study. Those specimens had been studied by I. Tomiyama (1936).

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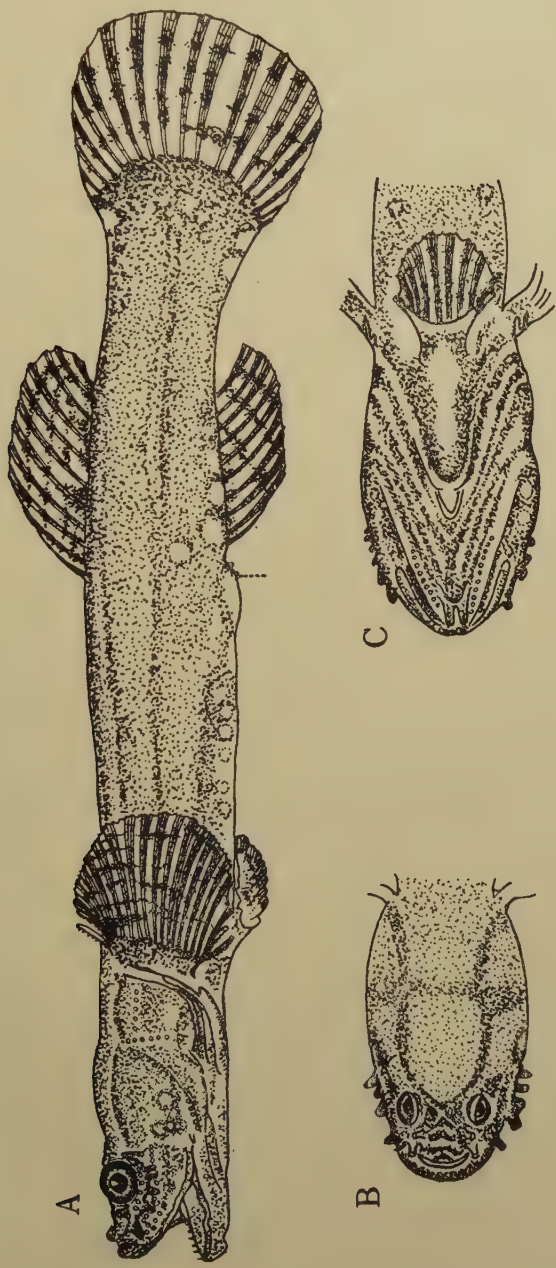
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EXPLANATION OF PLATE 2

Luciogobius saikaiensis n. sp.

- Fig. A. Holotype, 41 mm in total length.
- Fig. B. Dorsal side of A.
- Fig. C. Ventral side of A.



Luciogobius saikaiensis n. sp.



有明海奥部におけるシヨ ウキハゼの
生 態, 生 活 史

道 津 喜 衛

The bionomics and life history of the goby,
Triaenopogon barbatus (Günther) in the
innermost part of Ariake Sound

Yosie Dôtu

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有明海奥部におけるシヨ ウキハゼの 生態, 生活史^{1,2,3)}

道 津 喜 衛

The bionomics and life history of the goby,
Triacnopus barbatus (Günther) in the
innermost part of Ariake Sound

Yosie Dôtu

は し が き

有明海の魚類相が日本の他の内湾水域のそれと較べて特異なものであることは多くの研究者がすでに報告している (Tanaka, S. 1931: 内田, 塚原 1955)。

筆者は当教室で行っている「有明海産魚類生活史の研究」の一部として 1947 年 (昭和 22 年) 以来, 同海域に産する二十余种のハゼ類の生態, 生活史の研究を行い, その結果からそこに産するハゼ類の生活相についても他の内湾のそれと較べてみて多くの特異点があることを確かめることが出来た。

ここでは有明海奥部に多数棲息するシヨ ウキハゼ *Triacnopus barbatus* (Günther) の生態, 生活史について, それと密接な生活関係を保ちながら棲んでいると考えられる近縁の 2 種類のハゼ: シロチチブ *Tridentiger undicervicus* Tomiyama およびシマハゼ *Tridentiger trigonosephalus* (Gill) との相互の生活関係を考えながら述べる。

はじめに本研究にあたり懇切なる御指導と原稿の御校閲を頂いた内田恵太郎教授に 深謝すると共に, 種々の御助言と御援助を頂いた佐賀県水産試験場稲並芳幸場長, 同試験場有明海分場山口正市技師はじめ同分場職員の方々, 大分県水産試験場高田分場増田守夫分場長, 佐賀県水産課脇田二郎技師 (ともに前佐賀県水試有明海分場長) の諸氏に 厚く御礼申し上げます。

有明海奥部におけるシヨ ウキハゼ, シロチチブおよび シマハゼの棲息環境とそれら相互の生活関係

有明海奥部に棲むチチブ属 (Genus *Tridentiger* Gill) のハゼはシロチチブとシマハゼの 2 種類のみであり, チチブ *Tridentiger obscurus* (Temminck et Schlegel) はこれまで採集された例がない。筆者の調査によると有明海奥部にそそぐ諸川 (例えば 福岡県

1) 九州大学農学部水産学教室業績。

2) 本研究の一部は農林省農林漁業技術試験研究補助金によつた (内田恵太郎)。

3) この研究内容の一部はすでに 1950 年 (昭和 25 年) 10 月 30 日, 日本水産学会九州支部大会 (於長崎市) で講演発表した。

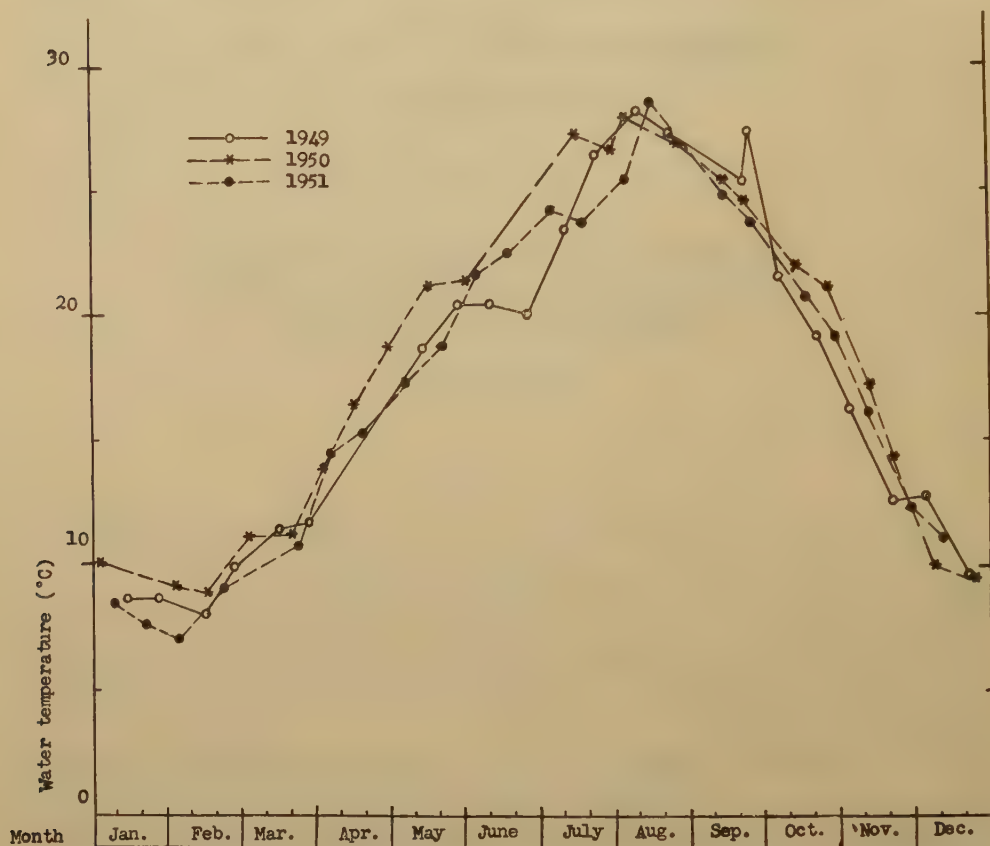


Fig. 1. Seasonal change of water-temperature at "Shintoko" oyster-bed, 4~5 meters deep at the flood, where the three gobies, *Triaenopogon barbatus*, *Tridentiger trigonocephalus*, and *Tridentiger undicervicus*, spawned together with in May, 1950. Observational data by the Ariake-kai Branch of Saga Prefectural Fisheries Research Station.

矢部川、佐賀県塩田川、同県鹿島川、浜川)の下流漁水域には他の九州各地の諸川(例えば福岡市室見川、八代市球磨川、宮崎市大淀川など)の下流漁水域に見られるようにチチブがそこに棲むハゼ類の中で最も優勢種であるような水域は見られなかつた。有明海奥部ではチチブに代つてこの水域の特産種である同属のシロチチブが川口から沿岸水域にかけて見られ、またチチブ属の近縁種とされているシヨウキハゼが甚だ多いことは同海域の特異な環境条件と併せ考えると興味がある。そこではシヨウキハゼ、シロチチブ、シマハゼはいずれも底棲生活を送っているが、それらはほぼ同じ水域に棲んでいる (Fig. 2)。

有明海奥部の佐賀県側におけるこれら3者の棲息量については、同水域で操業する各種の漁具(例えば、もち網、たけたてあんこう網、しげ網、はぜ網、ふくろ網など: いずれも潮流を利用した定置網)の漁獲物中に含まれるそれらの量の比較、および主として佐賀県沿岸で行つた天然棲息場における観察の結果から筆者はシヨウキハゼ>シマハゼ>シロチチブの

順であると予察的な判断を下しているが，現在のところではその量的関係を数量として表現できるまでに到っていない。またこれら3種類のハゼの魚体の大きさについては，成魚の魚体測定の結果からシヨ ウキハゼ>シマハゼ>シロチチブの順であつた（道津 1957b）。

干潮時に干潟で観察した資料によつてこれら3者の棲息場についてさらに詳しくみると，シロチチブはアサリ *Paphia (Paratapes) undulata* (Born) の養殖場となつていような砂泥質のやや固い地盤の干潟に多く（例えば福岡県地辺洲，同県中島アサリ養殖場，佐賀県六角川々尻網洗洲など），シヨ ウキハゼは軟泥の干潟で，隠れ場（shelter）として利用できるカキ殻の多いスミノエガキ *Ostrea rivularis* Gould の養殖場およびその周辺部に多く（例えば佐賀県鹿島市浜町新床スミノエガキ養殖場，同町新床沖モガイ採苗地など），シマハゼはこれらシロチチブ，シヨ ウキハゼの棲息場の最低干潮線附近の浅所および川の滞（みお）筋に多いようである。

これらのハゼはいずれも附着卵を産むが，それらの卵を産み附ける産卵室としては主にカキ殻を利用してゐた。産卵期にはカキ殻の多い上に述べたシヨ ウキハゼの棲息場にはシヨ ウキハゼのほかにはシロチチブおよびシマハゼの成魚も多数見られた（Fig. 4）。

この水域におけるシマハゼの産卵期は4～6月（盛期は5月），シヨ ウキハゼとシロチチブの産卵期はともに5～9月（盛期は7月）であり，シマハゼの産卵盛期とあとの2者の産卵盛期との間には時期のずれが認められる。また産卵期が重なるシヨ ウキハゼとシロチチブが同じ産卵場（例えば先に述べたスミノエガキ養殖場）を利用する場合には，魚体の大きなシヨ ウキハゼは大型のカキ殻を，魚体の小さなシロチチブは小型のカキ殻を産卵室として利用する傾向が認められた。新床スミノエガキ養殖場の干潟における観察によると（1950年5月）一つのスミノエガキ死殻の塊のうち大型の貝殻内にはシヨ ウキハゼが，また小型の貝殻内にはシロチチブが産卵していた例も2例あつた（Table 2：Fig. 3）。

なおシヨ ウキハゼの棲息，産卵場である新床スミノエガキ養殖場における漲潮時の水温の周年変化は7～28°Cであつた（Fig. 1）。

これら3種類のハゼの仔魚はいずれも全長15 mmの大きさまで沿岸水域で游泳生活を送つていたが，例年6～7月の間にはこれら3種類の仔魚が，また7～10月の間にはシヨ ウキハゼとシロチチブの仔魚が同時に，同じ漁具（例えばもぢ網）で多数獲られた。

これらの仔魚の消化管内にはいずれの種類にも小型の浮游性橈脚類が見られた。これらはいずれも全長15～17 mmの稚魚初期に游泳生活から底棲生活に移るが，底棲生活を送つていた稚，幼魚の棲息場は先にのべた成魚の棲息場ほど種類による差がはつきりせず，それぞれの種類の成魚棲息場に3種類の稚，幼魚が混つて棲んでいるのが見られた（Fig. 5）。

消化管内容物については，シロチチブは稚，幼魚から成魚までの各发育期を通じて水底の有機堆積物が主体であつたが，シヨ ウキハゼ，シマハゼのそれは環形動物，甲殻類，小型の魚類などを含む小動物が主体であつた。なおシヨ ウキハゼ成魚の消化管内にシマハゼおよびシヨ ウキハゼの若魚が見られた例もあつた。

これら3種類のハゼはいずれも1年魚ではなく，生後満1年経つと大部分の個体は成魚となり，産卵に与るが，産卵後も生残り，少数の個体は生後満3年以上も生き，日本産のハゼ類の示す成長型の中では同じ型に属すると考えられる。従つて有明海奥部では同じ沿岸水

域で一つの底棲魚群衆をなしているこれら3種類のハゼの各年級群が空間的にまた時間的に深い関係を保ちながら生活を続けているわけである。

シヨウキハゼの生活史

分布：シヨウキハゼは支那、朝鮮、台湾および日本に分布することが知られており、日本では東京以南の各地の内湾に産するとされているが、九州有明海奥部には特に多い。

産卵：二次性徴は生殖孔突起の形態差に最も著しく現われる。すなはち雄の突起は細長く、その先端は尖っているが、雌の突起は太く短く、その先端は截形をなし、先端周縁に皺がある。この突起の形態差は産卵期の成魚において最も著しいが、産卵期以外の時にも全長40 mm を越える個体ではこの差によつて外部から雌雄の判別ができる。

歯列の一部は特異な三尖頭歯よりなっているが、歯形および歯列には雌雄差は認められなかった。

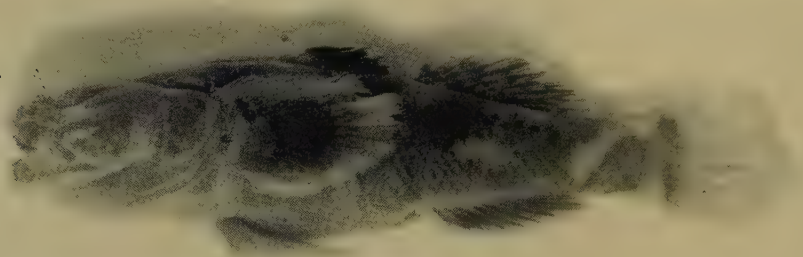


Fig. 2. *Triaenopogon barbatus* (Günther), $\frac{4}{3} \times$.
female adult, 70 mm in total length.

成熟生殖巣をみると、成熟卵巣では一般のハゼ類のそれに見られるように卵巣容積の殆ど全部を占める大型熟卵とその間にある小型未熟卵とよりなり、両卵群の間にははつきりした形状の差が認められた。すなはち成熟卵は球形またわ楕円球形をなし、径 0.48~0.90 (ホルマリン固定の20個の卵について測定)、卵黄は淡黄色をなし、その中に多数の小油球が認められ、卵膜にはすでに附着絲叢が見られるが未熟卵は卵径 0.05 mm (固定卵20個について) 以下の半透明のものである。

成熟卵巣卵を4尾についてその全数を数えた結果は1個体につき 2,610~23,365 であつた (Table 1)。

Table 1. Number of the ripe ovarian eggs of *Triaenopogon barbatus* (Günther).

No. of specimens	Total length in mm	Body length in mm	Estimated age	Number of ovarian eggs		
				Right ovary	Left ovary	Total
1	56	—	1	—	—	2,610
2	60	49	1	2,574	2,659	5,233
3	97	80	2	11,336	12,027	23,365
4	120	100	3	6,830	8,427	15,257

これらの熟卵はその形状および後に述べる天然の附着卵数からみて全卵が同時に産み出されると考えられるが，一産卵期に同じ雌成魚が何回産卵に与るかについては分っていない。

成熟精巢は乳白色の厚みのある帯状をなし，腹腔後端部より腹腔背面に沿つて前方に伸び，その先端は腹腔の前部約 1/4 のところまで達する。精巢内には乳白色の多数の小胞が横に並んでいる。精巢の後端部には G. F. Weisel (1949) が“Seminal vesicle”と仮称している附属器官がある。この器官は一葉の厚みのあるあめ色の帯状体をなし，腹腔後端で精巢と合し，その内部には多数の透明な小胞が縦に並んでいる。シロチチブとシマハゼの成熟精巢ではこの附属器官は前部が二葉に分れている (Eggert, B. 1931)。

産卵期は天然卵が採集された時期，卵巢内卵の熟度および仔魚の出現時期からみて 5 月中旬から 9 月中旬までの長期に亘るようである (1950 年の調査による)。

産卵は先に述べたシヨ ウキハゼの普段の棲息場で多数見られた。産卵には干潟の浅い水溜りの中にある左右両殻の離れていないスミノエガキの死殻を産卵室として利用し，その

Table 2. Measurements on the oyster-shells, *Ostrea rivularis* Gould, in which the goby, *Triaenopogon barbatus* (Günther) spawned. The male parent fish were guarding over the attached eggs in the shells.

Observational data were mainly obtained from the spawning-ground, the muddy tidal flat of “Shintoko” oyster-bed in Ariake Sound, on May 18 and 29, 1950.

No. of shells	Height of shell in cm	Length of shell in cm	Total length of male parent fish in mm
1	7	12	110
2	7	18	—
3	9	7	90
4	9	7	90
5	9	11	109
6	9	13	97
7	9	16	—
8	10	8	—
9	10	13	—
10	10	14	—
11	10	15	—
12	11	8	—
13	11	15	—
14	12	7	73
15	12	7	101
16	12	9	—
17	13	9	81
18	14	10	—
19	15	11	—
20	19	12	—
N	20	20	8
R	7~19	7~18	73~110
M	10.9	11.1	93.8

内面に広く一層に卵を産み附けていた。産卵場にあつた卵の産み附けられていないカキ殻の内面には浮泥が沈積して汚れていたが、卵が産み附けられていたカキ殻の内面は少数の例外を除いては綺麗に掃除されていて浮泥はなく、真珠光沢に輝いていた。

観察した卵群 60 余例のうち約 1 割は卵の附いたカキ殻内に親魚が見られなかつたが他はすべて雄親魚 1 尾だけがその中に留つていた。またこの 60 余例の卵群のうち卵が左、右のカキ殻のうち一殻のみに産み附けられていた例はわずかに 1 例のみであつて、他はすべて左右両殻に卵があつた。

附着卵群のひろがりや円形または楕円形(径 5~12cm)をなすものが多く、卵は密に並んでいた。1 卵群の卵数は 2 例について 7,791 個, 15,841 個を数えた。

産卵室として用いられていたスミノエガキの貝殻は殻巾(7~19cm)、殻長 7~18cm(20 例について測定)であり、すべての例について殻巾或は殻長のいずれか一方はその中に留つていた雄親魚の体長より大きく、親魚がその中に入るのに十分の大きさのものであつた。またこの産卵室は同じ場所で同時に産卵していたシロチチブおよびシマハゼが産卵室として利用していたスミノエガキの貝殻より大型のものであつた(Table 2)。

観察した卵群六十余例のうちスミノエガキの貝殻以外のものを産卵室としていた例は干潟の水溜りに伏つていたサルボウ *Anadara subcrenata* (Lischke) の右殻(殻高 9cm)の内面に卵を産みつけていた 1 例のみであり、この場合にも雄親魚が貝殻の下に留つていた。この他にシマハゼ、シロチチブの産卵に見られるような、アカニシ *Rapana thomasi* Crosse, タイラギ *Pinna pectinata japonica* Reeve, タコ壺などを産卵室としていた例はなかつた(Breder, C. M. Jr. 1950, '54)。

シヨ ウキハゼが産卵室としていたスミノエガキの貝殻は左右両殻がわずかに開いていたが、その隙間は貝殻の中に留つていた雄親魚が辛うじて通り得る程度の大きさのものが多かった。

親魚：産卵期にシヨ ウキハゼ成魚の頭部が著しく縦扁し、吻部は鈍く尖り、頭巾は体巾と較べて著しく大きいという形状は上に述べたようなカキ殻の中に潜み、その中で産卵する習性に適応した形であるのかも知れない。産卵期のシマハゼ、シロチチブの成魚にも上に述べたシヨ ウキハゼ成魚と同様の形状が見られるが、この 2 種類のハゼの産卵習性もすでに述べたようにシヨ ウキハゼのそれに似ている(檜山 1936: 道津 1957a)。

貝殻内に留つていた雄親魚の行動は鈍く、水中から貝殻を取り出して左右の殻を開いても早く逃げようとしなかつたのでその生態の観察と採集は容易であつた。

調査した 20 余例の卵群について、同一卵群中の全卵は発生段階がほぼ等しく、同じ雌親魚によつて同時に産み附けられたと考えられ、シロチチブ、チチブおよびシマハゼの卵群に見られるような同じ卵群内に明らかに産卵された時間が違うと考えられる著しく発生段階の異つた 2 つ以上の卵群が混つて附いていた例は見られなかつた。

産卵場の干潟での観察採集によるとそこでは雄成魚の数は雌成魚より著しく多く、また産卵後と思われる雌魚は殆ど採集されなかつた。しかるに産卵期に附近の川筋の湾で操業した各種の定置網(例えば、ふくろ網、もち網)では産卵前の雌魚と共に産卵後の雌魚が多数獲れた。また数多い採集において干潮時に産卵場の干潟で産卵行動或はそれに関連があ

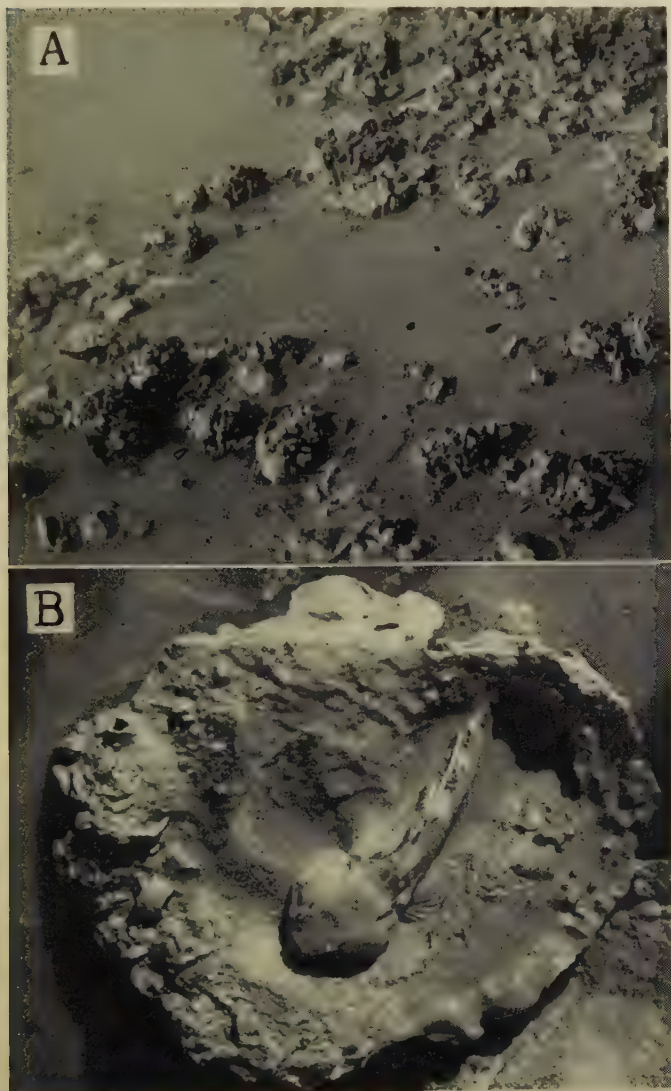


Fig. 3. Spawning-ground and male parent fish of *Triaenopogon barbatus*, guarding the attached eggs.

- A. Dead shells of *Ostrea rivularis* Gould on the muddy tidal flat of the oyster-bed in Ariake Sound where the goby spawned.
- B. Male parentfish, guarding the spawn in an oyster-shell, upper shell removed. $\times \frac{2}{3}$.

と思われる行動を一度も観察することができず，干潟で採集した発生初期の卵はいずれも受精後数時間を経たと思われる発生段階であつたことなどから，産卵は産卵場の海底が

海水で蔽われた漲潮時に行われ、潮がひいて干潟が現われる時には産卵を終った雌親魚はすでに産卵場を去っており、雄親魚だけがそこに留ると考えられる。

産卵期は先にも述べたように5～9月の長期に亘るが、卵の孵化時間は短く（水温 25°C 前後で約4日間）、産卵期の全期間を通じて卵を護っていた雄親魚の中には多数の大型魚が見られ、これらの雄親魚中には産卵末期になるに従って体は痩せ、鱗は脱げ、外部は傷つき、体色は褪せた個体が目立つて増えたが、これらの点から考えると雄魚（特に大型の雄魚）は一産卵期に多数回の産卵行動に与ることが考えられるが、この点について産卵場の雄親魚に個体識別の標識を付けて産卵期の行動を長期に亘って観察し続けるか、または室内水槽で飼育産卵させて調べるなどの方法による実証はまだ行っていない。また産卵行動に深い関係があると思われる雌雄成魚の魚体の大きさの比較（予察的には雄>雌と考えている）、およびこの水域のショウキハゼ個体群の性比と産卵場局地における産卵成魚間に現われる性比の時間的な推移の問題などについては現在までの調査では殆ど分っていない（Guitel, F. 1892, 1895: MacGinitie, G. E. 1939: Tavalga, W. N. 1954, 1955: 石川, 中村 1941: 道津 1955）。

卵発生: 受精卵は長径 1.46～1.60 mm（20個の卵の平均値 1.54 mm）、短径 0.52～0.58 mm（平均値 0.55 mm）の長楕球形をなし、卵膜先端は円く、先端近くにごく浅いくびれがあるが、卵によつてはこのくびれが見られないものもある。この卵形はチヂブ属のハゼの

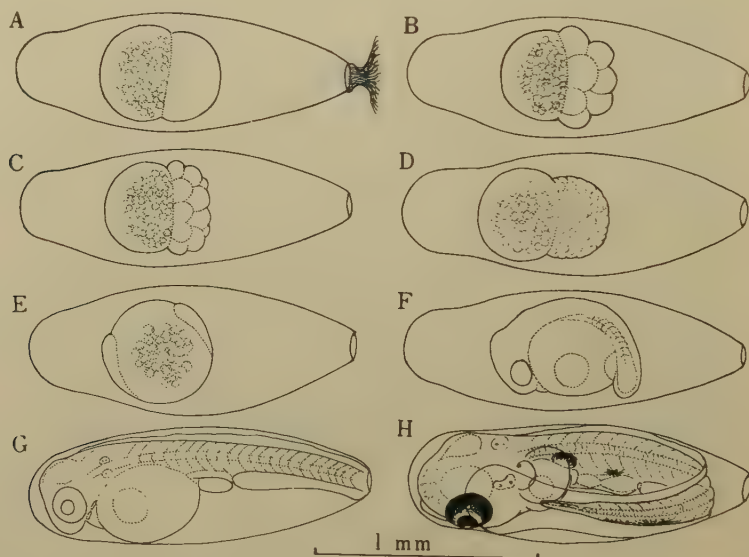


Fig. 4. Egg development of *Triaenopogon barbatus*.

A. Before cleavage, 30 minutes after insemination. B. 8 cell stage, 1 hr. 30 min. C. 16 cell stage, 2 hr. D. Blastula stage, 4 hr. 20 min. E. Formation of embryonal body. F. 8 myotome stage, eye-balls and Kupffer's vesicle formed. G. Optic lenses and otocysts formed. H. Just before hatching, 4 days after insemination.

The water-temperature ca. 25°C: adhesive filaments at basal end of B~H omitted.

産む西洋梨形のものと異つている。卵膜基部には附着絲叢があり，それによつてカキ殻内面に附いていた。卵黄内の油球は発生初期には多数の小油球群をなすが発生が進み胚体に眼胞が現われる段階になるとそれらは合して1個の大型の油球となる (Fig. 4, A~H)。多細胞期における卵黄と細胞部とのみかけ上の大きさの比 (Yolk-Cytoplasm Ratio: Tavalga, W. N. 1950 a) は4 : 5。孵化直前の胚心臓の10搏動に要した時間は3.0~3.5秒 (水温 22.0°C, 同一卵群から取つた5卵についてそれぞれ5回宛測定した計25回の測定値平均は3.2秒)。孵化前になると胚体運動が盛になり，卵膜先端部に位置する胚頭上部に顆粒状の多数の孵化酵素腺が現われ，卵膜先端に一つの孵出孔が裂け，胚体はその孔を通つて頭部を先にして出てくる。卵膜は胚体が孵化して出た後でもその形が崩れない。孵化までの時間は水温 25°C 前後で約4日間であつた (檜山 1936 : 中村 1942 : 小川 1952)。

仔，稚魚： 孵化直後の仔魚は生時の全長 2.50~2.55 (5尾についての平均値 2.54 mm)。体の形状はヘゼ類一般の仔魚と大差ない。

体表面の黒色胞は数が少く，腹部および尾部の腹側正中線に点在する。黄色胞はわずかに尾部の最大黒色胞と同位置に見られるだけである。体側筋肉数 $8 + 16 = 24$ (脊椎骨数 $10 + 16 = 26$) (Fig. 5, A)。

孵化後約3日間で卵黄を吸収し尽すが，全長は孵化当時と殆ど変らない。黒色胞が増し，黄色胞も尾部のほかに頭部および腹部にも現われている (Fig. 5, B)。

全長 10.7 mm⁴⁾ (Fig. 5, C : 以下の仔，稚魚の記載はすべてフォルマリン固定，アルコール保存の標本によつた) の仔魚は体長 9.0 mm, 体高 1.7 mm, 頭長 2.5 mm, 眼径 0.5 mm。背鰭 VI, 11 : 臀鰭 11, いずれも鰭条定数に達している。胸鰭には鰭条は認められない。腹鰭は左右合して菱形をなし，鰭条原基が現われている。口は頭部先端に斜上方を向つて開く。体側の黒色胞は数が少く，尾部の腹側正中線および尾鰭基底部にそれぞれ数個ずつ認められる。体側筋肉数 $10 + 15 = 25$ 。腹部の体側筋肉を透して体の外部から大型の鰾が腹腔中央部の脊椎骨下にあるのが分る。

全長 15.2 mm (Fig. 5, D) の後期仔魚は体は側扁し，口は斜上方を向つて開く。頭胴長 7.0 mm, 頭長 3.7 mm, 眼径 0.75 mm, 体高 2.5 mm。胸鰭 22で定数となつている。左右の腹鰭は合して楕円形をなし，I + 5。尾部にはすでに鱗の原基が現われている。

全長 16.0 mm (Fig. 5, E, F) の初期稚魚は体巾が増し，体の横断面は円味を帯びている。頭部および体側の黒色胞は増し，体側に5~6条の横縞をなしている。口はほぼ水平に開く。両眼間隔は大きく，眼径の1.3倍。

全長 17.0 mm (Fig. 5, G, H) の後期稚魚は体形は成魚に似て頭部は縦扁し，腹鰭は盃状をなし，尾鰭後縁はなお截形をなす。眼下部にはすでに鬚が認められる。

全長 13 mm 以上の仔魚では消化管の回転状態および鰓耙の形状は成魚のそれらと同型である。鰾は仔，稚魚においては比較的厚い壁よりなり，腹腔内に大きな空所を占め，その壁には血管網の分布が認められた。

4) 全長 4~10 mm のショウキハゼの仔魚と考えられる多数の標本が採集されているがこれと形態がよく似ているシロチチブの仔魚は全長 10 mm 以下のものはまだ採集されず，従つてそれ以下の大きさの仔魚については両種間の区別を明らかにすることができなかつたので，ここには両者の区別が明らかになつた 10 mm 以上のショウキハゼ仔魚について記載した。

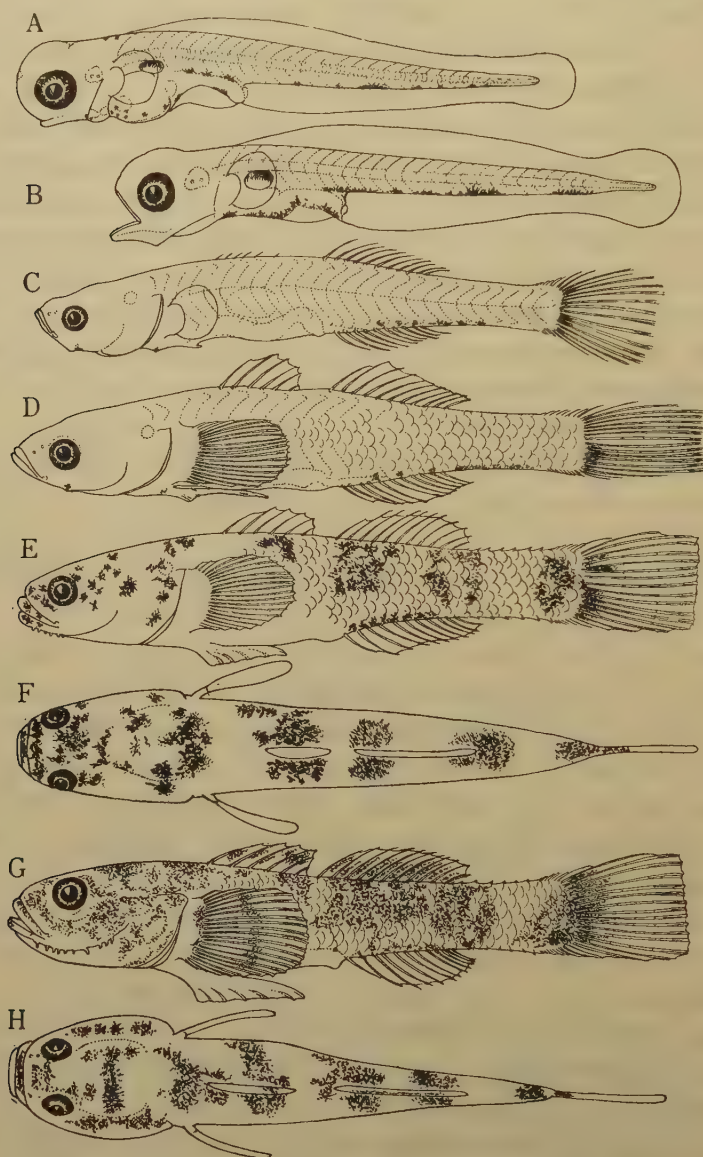


Fig. 5. Larvae and juveniles of *Triaenopogon barbatus*.

A. Newly hatched larva, 2.5 mm in total length. B. Larva, 3 days old, 2.6 mm. C. Postlarva, 10.7 mm. D. Postlarva, 15.2 mm. E. Early juvenile, 16.0 mm. F. Diagrammatic, dorsal view of E. G. End of juvenile, 17.0 mm. H. Dorsal view of G.

A and B drawn from living specimens, D~H from preserved ones.

以上述べた各発育段階の外部形態の特徴を示す仔、稚魚の大きさは個体によつて差があり、例えば全長 17.0 mm の仔魚でも上に述べた 15.2 mm の仔魚と同じ外形を示すものがある。

り，また全長 15.0 mm の大きさで上に述べた全長 17.0 mm の後期稚魚と同じ外形を示す個体もあつた。この仔，稚魚にみられる個体変異は一般のハゼ類の仔，稚魚に広く認められるところであるが，その起因については分っていない（道津，水戸 1955：道津 1957a）⁵⁾。

全長 10～17 mm の仔，稚魚は有明海奥部では 7 月～10 月の間に川筋の渚でアキアミ *Acetes japonicus* Kishinouye を漁獲の主目的として操業するもち網で多数獲られたが，このもち網（移動式定置網）の性質からみて，これらの仔，稚魚は川口および沿岸水域で游泳生活を送っていると考えられる。

全長 17 mm を越える稚，幼魚は 8～10 月に成魚の棲む干潟で底棲生活を始めていた。

食性：全長 13～35 mm の幼期の消化管内には橈脚類，甲殻類の Mysis 幼生，仔魚などの小動物が見られた個体もあつたが，大部分の個体では消化管内は空であつた。

産卵期に産卵場で採集した雄成魚の消化管内にはカニ類の幼期，アキアミ，テッポウエビ類（Caragonidae），シヨ ウキハゼおよびシマハゼの幼魚などの小動物が認められた。また卵を護つていた雄親魚の消化管内に卵発生末期のシヨ ウキハゼの卵が多数認められた例もあつた（道津 1954）。

産卵期に佐賀県塩田川々尻でふくろ網で獲れた成魚の消化管内容はハゼクチ *Synechogobius hasta* (Temminck et Schlegel)，アリアケシラウオ *Salanx ariakensis* Kishinouye，シマフグ *Fugu xanthopterus* (Temminck et Schlegel)，ヒラ *Ilisha elongata* (Bennett) などの若魚の他にシラエビ *Pasiphaea sivado* (Risso)，アキアミ，およびベイカ *Loligo beka* Sasaki などの游泳性の小動物が認められた。

成長：シヨ ウキハゼの鱗は腹部の腹側に円鱗が見られる他はすべて櫛鱗であり，この櫛鱗の形状はシマハゼの鱗に似る（Takagi, K. 1952）。櫛鱗の鱗紋の排列には疎密があり，密に並ぶ部分は冬期および産卵期に現われる。先に述べた生態，生活史を考えに入れて採集全標本の全長組成を調べ，併せて鱗相による検討も加えてシヨ ウキハゼの成長を調べた結果は：生後満 1 年で全長 40～85 mm となり，大部分の個体は生後 1 年で成魚となつて産卵に与り，生後 2 年で全長 85～115 mm，小数の個体は満 3 年以上生きて全長 120 mm を越えることが予報的に言いうる。調査個体の中で産卵に与ると考えられた最小個体は雌魚全長 53 mm（体長 43 mm），雄魚は全長 56 mm であつた。

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5) 先に述べた仔，稚魚の記載に用いた標本は 500 尾を越える仔，稚魚標本をまず全長に従つて階層別けをし（単位：1 mm），各階層別にその中に含まれる標本の外形を比較検討し，それぞれの階層に属する標本の大多数の外形を代表すると思われる個体を選んだものである。（Tavolga, W. N. 1950b）。

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Résumé

Triaenopogon barbatus Günther is plump goby, some 70 mm in total length, with barbels and trilobed teeth bands (Fig. 2). It is distributed in China, Formosa and Japan, and abundantly found in Ariake Sound, on the western coast of Kyushu, Japan. Ariake Sound is a large bay of muddy, shallow water, less than twenty metres in depth at the inner part; and there occur fast tidal currents. The fish-fauna of this sound, including more than twenty species of Gobioid fishes, shows special characteristics different from other bays of Japan (Fig. 1).

The three allied Gobioid fishes, *Triaenopogon barbatus* (Günther), *Tridentiger trigonocephalus* (Gill) and *Tridentiger undicervicus* Tomiyama live a similar bottom-life in the same muddy shallows in the innermost part of the sound. *Triaenopogon barbatus* (Günther) inhabits the oyster-beds of soft muddy tidal flat (Fig. 3).

The sexes are easily distinguished in this goby of over 40 mm in total length, by the structure of the urogenital papilla. In the male, this organ is conical and pointed at its tip, whereas in the female it is truncate at its tip.

The ripe ovarian eggs included two egg-groups, one the ripe egg-group, 0.48~0.90 mm in egg-diameter, and the another the unripe egg-group, less 0.05 mm. This ripe egg-group seemed to be spawned at one time. The number of ripe ovarian eggs is enumerated 2,610 to 23,365 in four individuals (Table 1).

The ripe testis is a white, thick band-form organ with a leaf of the appendant organ ("Seminal vesicle": Weisel, G. F. 1949).

The spawning occurred in the above-mentioned habitat from May to September, mainly in July. The spawned eggs were deposited, in one-layer, on the inner surface of the cleaned empty shell of *Ostrea rivularis* Gould on the tidal flat. The number of eggs of one mass was enumerated 7,791 and 15,841 in two cases; and each spawned egg-mass wholly consisted of the eggs in similar developmental stage as were observed in over twenty cases.

The spawning-act seemed to occur at the tidal flood, and when the act finished the female parent fish left the nest, whereas the male which had remarkably compressed head, was found guarding the spawned eggs until they hatched (Fig. 3).

The observational data collected from the spawning-ground seemed to show the polygamous habit of the large male fish. It is yet unknown how many times one female fish spawned in one season. In this species, the size of the nest generally corresponded with the size of the guarding male parent fish. Also the size-order of the nest (oyster shell) of the three, allied gobies, spawned in

the similar spawning-ground of oyster-bed at the same time, were recognized as corresponding with the size-order of the male parent of these gobies; that is *Triaenopogon barbatus*, *Tridentiger trigonoccephalus*, and *Tridentiger undicervicus* (Table 2).

The spawned egg is demersal, ellipsoid in shape, about 1.5 mm in longer axis, 0.5 mm in shorter axis, with a bundle of adhesive filaments at its basal end. The incubation-period is about four days at the water-temperature about 25°C (Fig. 4).

The newly hatched larva is about 2.5 mm in total length. This larva consumed its yolk entirely in three days after hatched at the same water-temperature in egg-development (Fig. 5).

The post-larvae, less than 10 mm in total length, was not yet collected. The post-larvae of 10~17 mm were found to live a swimming-life in the deeper drainage course of the mud flat from June to October, feeding on planktonic Copepods and Crustacean larvae. Together with the larvae of this goby, two gobies, *Tridentiger trigonocephalus* and *T. undicervicus* of similar size, 10~15 mm in total length, were collected with the set-nets in the estuary from June to July.

The juveniles, over 17 mm in total length, were found from July to October entered into the bottom-life in the same habitat of the adult.

The examination of gut-contents of the young as well as the adult fish showed that Annelida, small Crustaceans, squid, and young fish, including the young of this goby and *Tridentiger trigonocephalus*, constitute the diet.

This goby seems to grow 40~85 mm in total length in a year, and to become mature in most individuals; 85~115 mm in two years; over 120 mm in three years, based upon the size-frequency. The smallest female adult examined was 53 mm in total length (43 mm in standard length). The life-span seemed to be over three years.

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アナハゼの卵発生と仔魚前期

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On the development of egg and prelarval stage of a marine
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アナハゼの卵発生と仔魚前期¹⁾

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On the development of egg and prelarval stage of a marine sculpin, *Pseudoblennius percoides* Günther

Shiro Fujita

は し が き

アナハゼ *Pseudoblennius percoides* Günther はカジカ科 Cottidae に属し、東北地方から九州地方に亘つて普通に見られる岩礁性の沿岸魚である。全長 200 mm 位になり、磯釣、磯刺網などによつて捕獲される。アナハゼ類の初期発生については、1932 年 1 月、内田恵太郎氏が朝鮮の鎮海湾内で採集されたマボヤの体内から魚卵塊を見出し、卵及びその卵から孵化した仔魚から考えて、アナハゼ属、若しくはこれに近縁な魚の卵であろうと推定報告されている以外には殆ど知られていない²⁾。筆者は 1955 年 12 月、門司市立和布刈水族館で飼育中のアナハゼを用いて人工授精を行い、孵化後約 4 日間飼育観察したので卵発生及び仔魚前期について報告する。アナハゼの雄成魚には大きな交接器があるが飼育水槽中で交尾を観察することは出来ず、又同一水槽中で飼育していた数尾の雌の腹部を切開し得た卵巣内からも受精卵を検出することは出来なかつた。

本研究に当り懇切な御指導を賜り、且つ原稿の御校閲を戴いた内田恵太郎教授に謹んで感謝の意を表する。

卵及び卵発生

熟卵 アナハゼの卵は数個 (3~10) の無色透明の油球を有する淡青緑色から淡黄緑色の球形の沈性凝集卵で不規則な平板状の塊をなしている。卵相互の粘着力は強いが、卵以外の他物には粘着しない³⁾。卵径は 1.6~2.0 mm で油球径は 0.05~0.3 mm であつた。この油球とは別に雲霧状の微小油球からなる油球群がある。卵黄の色は親魚の個体によつて卵塊毎に異なり、淡青緑色から淡黄緑色までいろいろの段階のものが見られ、卵発生が進

1) 九州大学農学部水産学教室業績、日本水産学会年次大会で講演 (1956 年 4 月、於東京) 本研究の一部は農林省農林漁業技術試験研究補助金によつて行つた (内田恵太郎)。

2) 内田恵太郎氏が朝鮮鎮海湾でマボヤの体内から発見した魚卵は塊をなし、卵径 2.0~2.2 mm で卵黄の色は各卵塊によつて異なり、殆ど無色のもの、レモン黄、黄、橙黄色などで卵径の $\frac{1}{6}$ ~ $\frac{1}{4}$ 位の大きさの油球が胚体の頭端にあつた (内田恵太郎 1932)。

3) 今までに明らかにされている沈性凝集卵を産むカジカ科の魚には、卵塊が他物に粘着するものとしなものがある。前者にはカジカ *Cottus pollux* (Günther) (田村 1937, 松田 1941), *C. semidcaber* (Cope) (Simon J. R. and Brown R. C. 1943), *C. bairdi punctulatus* (Gill) (Bailey J. E. 1952), ヤマノカミ *Trachidermus fasciatus* Heckel (塚原, 1952) などがあり、後者にはアナハゼの外に *C. hangiongensis* Mori (佐藤, 小林 1953), *Clinocottus recalvus* (Greeley) (Mottis R. W. 1951) が知られている。

むにつれて薄くなる傾向がある。油球も卵発生の後期に癒合して 1 個になる。

孕卵数 全長 168 mm, 体重 30 g の雌の卵巢重は 4 g, 卵巢内卵数は左卵巢 439 個, 右 465 個, 合計 904 個であつた。

材料 人工授精に用いたアナハゼは 1955 年 11 月 14 日, 下関市安岡の底刺網で漁獲され, 水族館の流水式水槽 (1 m × 1 m × 1 m) 中で約 3 週間飼育されたものである。同水槽にはアナハゼ (♂ 1, ♀ 5), タケノコメバル, カサゴ各数尾を収容していた。

人工授精 人工授精は 1955 年 12 月 7 日 12 時 25 分, 全長 ♀ 180 mm, ♂ 171 mm の個体を用い湿導法によつて行つた。

卵内発生 卵内発生には口径 360 mm × 高さ 240 mm のガラス鉢を用い, 適時海水を取り換えて止水で飼育した。孵化までの飼育水温は 16.2~18.5°C (室温) であつた。卵発生の諸経過は一般硬骨魚と大差はなかつたが, 目に黒色素胞を生ずる頃から斃死する卵が多くなり孵化率は悪かつた。

授精後 4 時間 55 分で胚盤隆起が完成し, 6 時間 15 分で第 1 分割, 10.5 時間で第 4 分割, 12.5 時間で第 5 分割を行い, 17 時間で Morula 初期に達する。53.5 時間で胚皮は卵黄径のほぼ 1/3 を掩い胚体の原基が現われている。76 時間で原口が閉じ, Kupffer 氏胞を生じ, 筋肉節 7~8 個が数えられる。93.5 時間で眼球が形成され, 筋肉節 13~15 個が認められる。4 $\frac{1}{2}$ 日で耳嚢が出来, 筋肉節 21 個がある。5 日で胸鰭の原基が現われ, 尾部は卵黄から離れ, 筋肉節は 35~36 個に増える。6 $\frac{1}{2}$ 日で目に黒色素胞を生じ, 筋肉節 40 個が認められほぼ定数に達する。約 13 日で頭部に孵化酵素腺を生じ, 口が開き, 腸管後部に大型黒色素胞数個が現われ, 胴部に黄色素胞が点状に散在する。授精後 17 $\frac{1}{2}$ 日で最初の孵化が見られた。孵出は頭部を先にして行われる。

仔 魚

孵化直後の仔魚 (10) は全長 5.6 mm, 卵黄 (長径 1.25 mm) は微青緑色で, 癒合して 1 個になつた油球 (径 0.01 mm) が胸鰭の基部下方面にある。口は開き胸鰭も既に備わる。筋肉節数は 10~11+29=39~40 (成魚の脊椎骨数 13+24=37) で肛門は魚の前方からほぼ 2/5 の所, 第 10~11 筋肉節下に開口している。仔魚膜鰭は第 1 筋肉節の僅かに前方に始まる。大型の樹枝状黒色素胞が腸管後部周辺に 3 個, 小型の黒色素胞が尾部中央部の腹中線上に 1~2 個あるが, この尾部腹中線上の黒色素胞は全然見られない個体もある。何れの個体にも体の背面及び頭部には黒色素胞は全く見られないが, 黄色素胞は胴部に点状に散在する。孵化後しばらくすると仔魚は水の表層, 中層を自由に游泳する⁴⁾。

孵化後 1 日の仔魚 (11) は大型樹枝状黒色素胞が腸管周辺及び卵黄の前端に見られ, 小型の黒色素胞 9 個が尾部腹中線上に一列に並び, 全長 6.3 mm に達する。

孵化後 4 日の仔魚 (12) は全長 7.3 mm に達し 卵黄も殆ど吸収し尽し, 頭部の発達いち

4) 内田恵太郎氏がマボヤの体内より発見した卵から孵化した孵化直後の仔魚は全長 7.0 mm, 卵黄は殆ど吸収し尽され, 目は黒く, 口広く, 肛門は魚体の前方より約 $\frac{1}{3}$ の所に開き, 胸鰭は発達し, 数え得る筋肉節数 9+28=37, 頭頂には 1~2 個の黒色素細胞の外に黄色素細胞があり, 消化管背面にも著しい黒色素細胞があり, 更に体の尾部腹中線上に約 17 個の小黒点列がある (内田恵太郎 1932)。

じるしく、下顎に歯が見られる。

孵化後2日から熱帯魚飼育用のブライン シュリンプ（商品名）の孵化幼生を与えたが、卵黄吸収後は飼育出来なかつた。

アナハゼの卵及び仔魚は内田恵太郎氏がマボヤの体内から発見した卵及びそれから孵化した仔魚と多くの類似点を有するが、卵径、卵黄の色、孵化仔魚の体長及び卵黄の大きさ、筋肉節、黒色素細胞の存在部位及び発達の状況などに於て相違する点が見られるので、かなり想像的ではあるが同一種の卵とは考えられない。

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R é s u m é

Pseudoblennius percoides Günther is a marine sculpin, commonly found on the shallow rocky coast of Japan.

The author operated artificial insemination of this fish on December 7, 1955, at the Mekari Aquarium in Moji City, Kyushu, and observed egg development and hatched larvae (Pl. 1~12).

The eggs are sticking to each other and laid in an egg mass, not adhering

to other substances. The egg is bluish green or yellowish green, spherical in shape measuring 1.6~2.0 mm in diameter with several colorless oil globules measuring 0.05~0.3 mm which become united into a single one in the course of development.

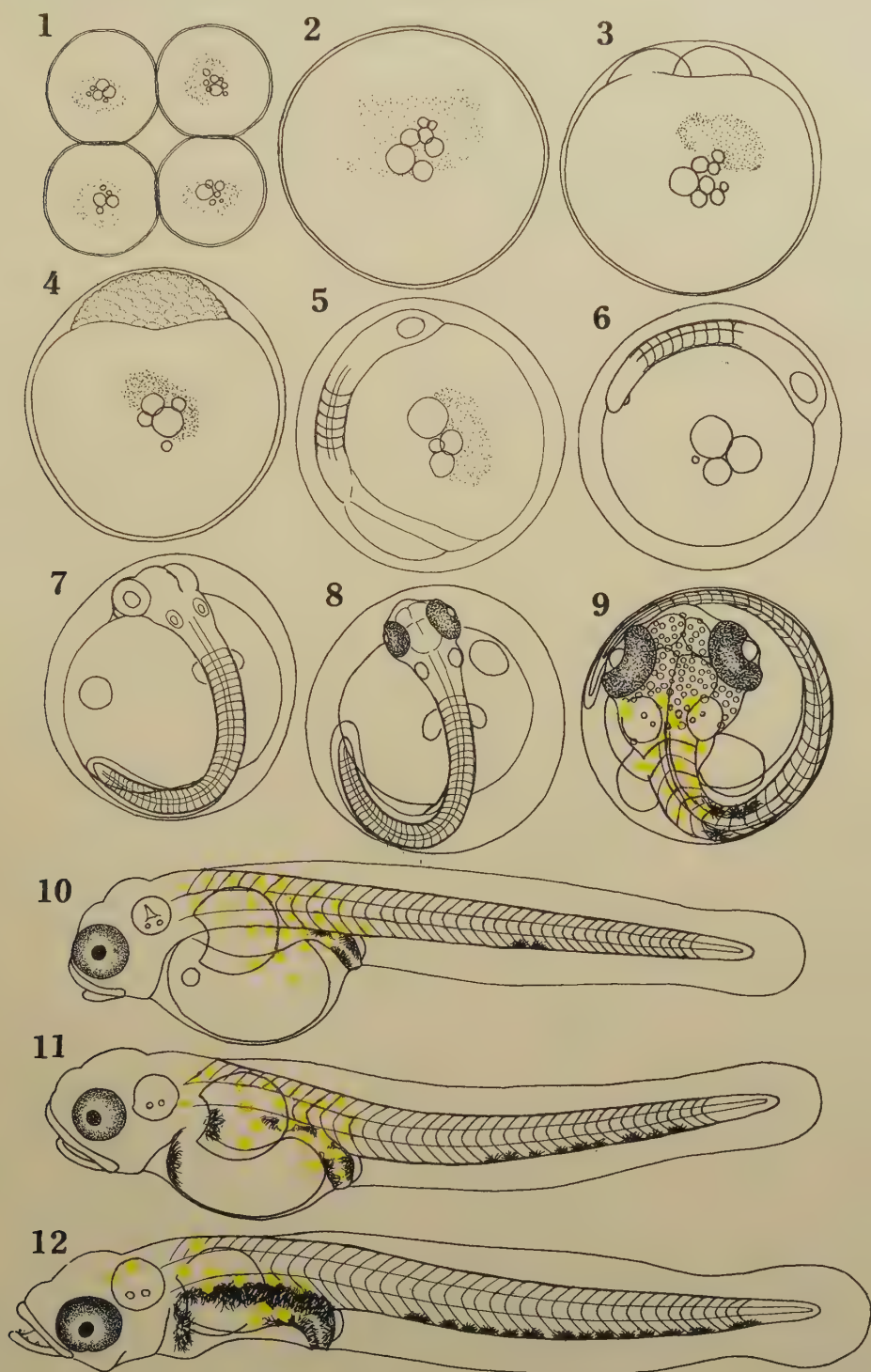
Hatching took place in about 17 days at the water temperature 16.2-18.6°C.

Newly hatched larva is 5.6 mm in total length with several melanophores and xanthophores. Some larvae lack the melanophores on the tail. The myotome number is 10~11+29=39~40 (vertebral number of this fish is 13+24=37). In one day after hatching many melanophores appeared on the tail. In 4 days the yolk is almost consumed.

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Explanation of Plate 9

- 1) A piece of egg mass.
- 2) Unfertilized egg.
- 3) 2 cell stage, 6 hr. 15 min. after insemination.
- 4) Morula stage, 17 hr. 5 min.
- 5) Eye vesicle formation, 5 myotome stage, 69 hr. 35 min.
- 6) Closure of blastopore, 7~8 myotome stage, 76 hr. 5 min.
- 7) Pectoral fin formation, 35 myotome stage, 5 days.
- 8) Appearance of melanophores on the eye vesicle, 40 myotome stage, 6 days.
- 9) Appearance of hatching enzyme gland on the head, melanophores on the alimental cannal, and xanthophores on the body, 13 days.
- 10) Larva newly hatched, 5.6 mm in total length.
- 11) Larva 1 day old, 6.3 mm in total length.
- 12) Larva 4 days old, 7.3 mm in total length.



アナハゼの卵発生と仔魚前期

イヌノシタの卵発生と仔魚前期

藤田 矢郎・内田恵太郎

On the development of the egg and prelarval stages of
a sole, *Cynoglossus robustus* Günther

Shiro Fujita and Keitaro Uchida

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イヌノシタの卵発生と仔魚前期^{1,2)}

藤田 矢郎・内田恵太郎

On the development of the egg and prelarval stages of
a sole, *Cynoglossus robustus* Günther

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は し が き

イヌノシタ *Cynoglossus robustus* Günther はウシノシタ亜目 Soleina のウシノシタ科 Cynoglossidae に属し本州中部以南から南支那海に分布し、泥質か砂泥質の海底に棲息する。

ウシノシタ類の卵および仔魚については Ehrenbaum, E (1905, 1909), 神谷尚志 (1922), Nair, R. V. (1902), Seshappa, G. et al. (1955) の諸氏の研究がある。

筆者等は 1956 年 (昭和 31 年) 7 月、門司市柄杓田 (瀬戸内海側) の底刺網漁船に乗つてイヌノシタの人工授精を行い、孵化後約 5 日間飼育観察したので卵発生および仔魚前期について報告する。

はじめに種の査定に当り御助言を戴いた 京都大学水産学科の 落合明氏に深謝の意を表する。

産卵期・卵および卵内発生

1956 年の門司市近傍に於けるイヌノシタの産卵期は 6 月下旬から 8 月上旬に及んだものと考えられ、6 月上旬から 8 月中旬に至る間、主として底刺網で漁獲されていた。なお同海域ではアカシタビラメ *Areliscus joyneri* (Günther) も 8 月上旬に熟卵 (多脂分離浮性卵、径 0.70~0.75 mm) を持ったものが漁獲されたのでその時期に産卵が行われるものと考えられる。

イヌノシタの熟卵は油球 5~15 個を有する無色透明の球形分離浮性卵で、卵膜にかすかな小亀甲模様があり、³⁾ 卵径 0.85~0.90 mm, 油球径 0.050~0.075 mm であつた。卵膜腔は狭い。油球は卵発生の途中で癒合することはない。

1) 九州大学農学部水産学教室業績および門司市和布刈水族館業績。

2) 本報告印刷費の一部は農林技術試験研究補助金によつた。ここに記して感謝の意を表する。

3) Ehrenbaum, E (1905, '09) によれば *Solea* 属のシタビラメ 4 種の卵はいずれも多脂分離浮性卵で、卵黄の周辺部に亀裂がある。神谷 (1922) によれば本邦産 *Solea* 属の 1 種の卵は多脂分離浮性卵で、卵黄の周辺に亀裂がある。Nair, R. V. (1952) によれば Madras 産 *Cynoglossus* 属のシタビラメ 2 種の卵はいずれも多脂分離浮性卵で卵黄に亀裂なく、卵膜にも特殊構造は見られない。倉上 (1914, '17) によれば, *Limanda angustirostris* Kitahara, *L. iridorum* Jordan et Starks, *Kareius bicoloratus* (Basilewsky), *Microstomus kitaharae* Jordan

人工授精^りは 1956 年 7 月 20 日 17 時 30 分に底刺網漁船上で漁獲直後の全長 352 mm の雌魚および全長 313 mm 雄魚を用いて乾導法によつて行つた。

卵発生の諸経過は一般硬骨魚のそれと大差なく、水温 26.2~27.5°C で授精後 16.5~17.5 時間で孵化した。卵発生の途中、胚体および卵黄上に黒色素胞および黄色素胞が現われ、胚体は頭部を先にして孵出する (Plate 17: Figs. 1~3)。

仔 魚

孵化直後の仔魚 (Plate 17: Fig. 4) は全長 1.75~1.85 mm, 5~15 個の油球 (径 0.05~0.07 mm) が卵黄 (長径 1.0 mm) の中央部より後方にある。筋肉節数 13+27~32=40~45。肛門は魚体の前方より約 4/7 の所、卵黄の直後に開口している。仔魚膜鰭は後頭部に始まる。小黒色素胞および黄色素胞が頭部、魚体背面、腹面および卵黄上に多数散在する (黄色素胞は見えにくい)。仔魚膜鰭上には色素胞は全くない。孵化直後の仔魚は卵黄を上にして水面に浮んでいる。

孵化後 6 時間の仔魚 (Plate 17: Fig. 5) は全長 2.2~2.5 mm, 卵黄長径 0.8 mm, 筋肉節数 12~13+45=57~58 (脊椎骨数 9+48~49=57~58)。肛門は魚体の中央よりわずかに前方に開口するようになる。黄色素胞群が目の周囲、胴部背面、肛門直上・腹面および尾部に現われ、特に尾部に於ては第 16~18 筋肉節、第 26~32 筋肉節、および第 42~53 筋肉節の間でそれぞれ 1 横帯を形成している。

孵化後 1 日の仔魚 (Plate 17: Fig. 6) は全長 3.3 mm, 卵黄径 0.35 mm, 筋肉節数 9+49=58。肛門は更に前進して魚体の前方より約 1/3 の所、第 9 筋肉節下に開口する。胸鰭の原基は現われているが、口はまだ開いていない。目には黒色素胞が現われていない。頭部直後の仔魚膜鰭の内部に隆起が見られ、その部分に黄色素胞が集つている。この部分以外の膜鰭上には色素胞は全くない。尾部の黄色素胞群は第 14~17 筋節、第 24~31 筋節間および第 41 筋節より尾端までの間にそれぞれ見られる。

孵化後 2 日の仔魚 (Plate 17: Fig. 7) は全長 3.25~3.50 mm に達し、卵黄 (径 0.2 mm) はかなり吸収され、目にも黒色素胞が現われ、口が開く。後頭部の仔魚膜鰭上に現われた隆起が発達して膜鰭状の突出物を生じ、その中に棘原基が認められる。孵化後 2 日から 3 日の間に斃死する個体が多かつた。

孵化後 3 日の仔魚 (Plate 17: Fig. 8) は卵黄を完全に吸収し尽し、全長 3.6 mm に達し、腸管が一回転している。後頭部に細長い三角形の膜鰭状の鰭条が発達し、この部分に黄色素胞が集つている。筋肉節数、肛門の位置などは上記の仔魚と変りがない。仔魚は水の上層、中層に浮んでいて、尾部をくねねす様に振つて泳ぐ。卵黄吸収後 2 日 (孵化後 5 日) で仔魚は全部斃死した。

et Starks, *Protopsetta herzensteini* (Schmidt) の卵はいずれも無脂分離浮性卵で、*Hippoglossoides hamiltoni* Jordan et Gilbert の卵は多脂分離浮性卵であり、上述の 6 種の卵はいずれも卵膜表面に縦横の網状または布目状の褶襞および小点が散在する。Budd, P. L. (1940) によると北米 California 産の *Pleuronichthys* 属のカレイ 3 種の卵はいずれも無脂分離浮性卵で、卵膜に微小亀甲模様がある。

4) 完熟した雌魚の卵巣は肥大するが、雄魚の精巣は肥大せず紐状である。

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R é s u m é

Cynoglossus robustus Günther is a common sole, distributed from the middle Japan to the southern China Sea. It inhabits mud or sandy mud bottom. The spawning season seems to extend from the end of June to early August in northern Kyushu.

On July 20, 1956, at Moji City, Kyushu, the authors carried out the artificial insemination of this fish, and observed the egg development and hatched larvae (Plate 17: Figs. 1~8).

The egg is bouyant and colorless, spherical in shape measuring 0.85~0.90 mm in diameter, with 5~15 colorless oil-globules measuring 0.050~0.075 mm. The outer surface of egg-membrane has faint, fine, hexagonal network sculpture.

Hatching took place in 16.5~17.5 hours at the water temperature 17.5~26.2°C.

Newly hatched larva (Plate 17: Fig. 4) is 1.75~1.85 mm in total length with 40~45 (13+27~32) myotome (The number of vertebrae of this fish being 9+48~49=57~58). The yolk is oval, 0.8 mm in long axis, with 5~15 oil-globules. Small melanophores and xanthophores are distributed on the head, trunk, tail and yolk-surface. The larval fins are free from any chromatophores.

In six hours after hatching, the larva attains 2.2~2.5 mm in total length (Plate 17: Fig. 5) with 57~58 (12~13+45) myotome.

Xanthophores form three cross bands in caudal part of the larva.

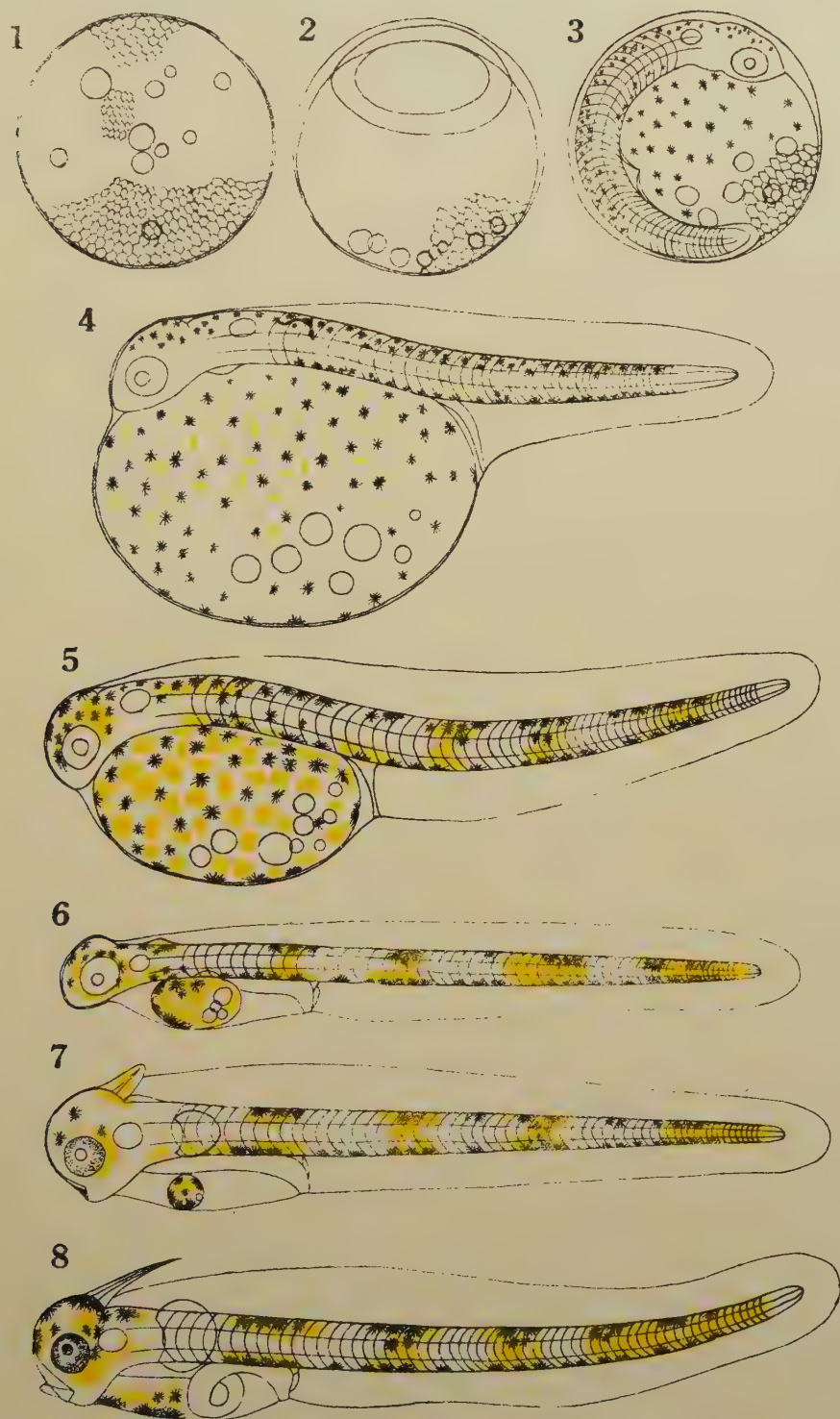
In one day after hatching, the anus of the larva which was situated under 12~13th myotome advances forward to under 9th myotome (Plate 17: Fig. 6).

In three days larva attains 3.6 mm in total length and the yolk is entirely consumed (Plate 17: Fig. 8). Above the head, at the anterior end of the dorsal membranous fin, a small spinous process is formed.

Fisheries Laboratory, Faculty of Agriculture,
Kyushu University.

Explanation of the Plate 17

- Fig. 1. Unfertilized egg (Hexagonal network extending through the entire space of the egg-membrane are drawn partially).
- Fig. 2. Gastrula stage, 4 hr. 30 min. after insemination.
- Fig. 3. Shortly before hatching, 15 hr. 30 min.
- Fig. 4. Newly hatched larva, 1.85 mm in total length.
- Fig. 5. Six hours old larva, 2.3 mm.
- Fig. 6. One day old larva, 3.3 mm.
- Fig. 7. Two days old larva, 3.5 mm.
- Fig. 8. Three days old larva, 3.6 mm.



イヌノシタの卵発生と仔魚前期

スズキの卵発生と幼期

水 戸 敏

On the egg development and larvæ of a Japanese
sea bass, *Lateolabrax japonicus* (Cuvier)

Satoshi Mito

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スズキの卵発生と幼期¹⁾²⁾³⁾

水戸敏

On the egg development and larvae of a Japanese sea bass, *Lateolabrax japonicus* (Cuvier)

Satoshi Mito

スズキ *Lateolabrax japonicus* (Cuvier) は我国沿岸に極めて普通に見られる魚で全長 100 cm に達し、北海道以南から朝鮮、台湾及び支那海に分布する。

本種の産卵については現在まで明らかでなく、秋冬の頃遼水域で行われると云われていた。筆者は 1955 年（昭和 30 年）1 月に、長崎県五島の南西端玉之浦町に於いて、本種の人工授精を行い卵内発生と孵化仔魚とを観察する機会を得た。また、1951 年（昭和 26 年）から行っている九州近海に現われる魚卵及び仔稚魚の研究の結果から、産卵及び幼期の形態、生態の一端を知ることが出来たので報告する。

本研究に当り絶えず御指導を賜わり且つ本稿の御校閲を戴いた内田恵太郎教授、研究上種々の便宜を与えられた九州大学天草臨海実験所前所長相川広秋教授、南海区水産研究所延岡支所長横田滝雄技官、長崎県五島玉之浦町漁業協同組合長藤原弁止氏及び貴重な標本を快く貸与された福岡県水産試験場川村久明技師に深謝する。

産卵

本種は我国各地に棲息するため産卵期に地方的差異はあるが、大体 10～4 月の間に行われるようである。九州近海では、採集された天然浮游卵と稚仔魚の出現時期及び成魚の生殖巣の状態とから考えて、11～3 月に産卵が行われるようである（第 1, 3 表及び第 1 図）。

遼水域での産卵についての調査は行っていないので不明であるが、外洋に面した沿岸附近でもかなり産卵が行われている（例えば日向灘、五島近海）。産卵時刻については、天然卵採集時の表面海水温度にかなり差異があるため正確に推定し難いが、昼間が多いように思われた。

卵及び卵内発生

(Plate 10, figs. 1~9)

人工授精は 1955 年 1 月 29 日午前 10 時に、ブリ落し網の漁獲物中から全長雄 580 mm, 雌 630 mm の個体を用い、乾導法によつた。用いた親魚の鰭式は背鰭：♂ 12 棘—1 棘 14 軟条, ♀ 12 棘—1 棘 15 軟条, 臀鰭：♂ 3 棘 8 軟条, ♀ 3 棘 9 軟条であつた。受精卵は、当

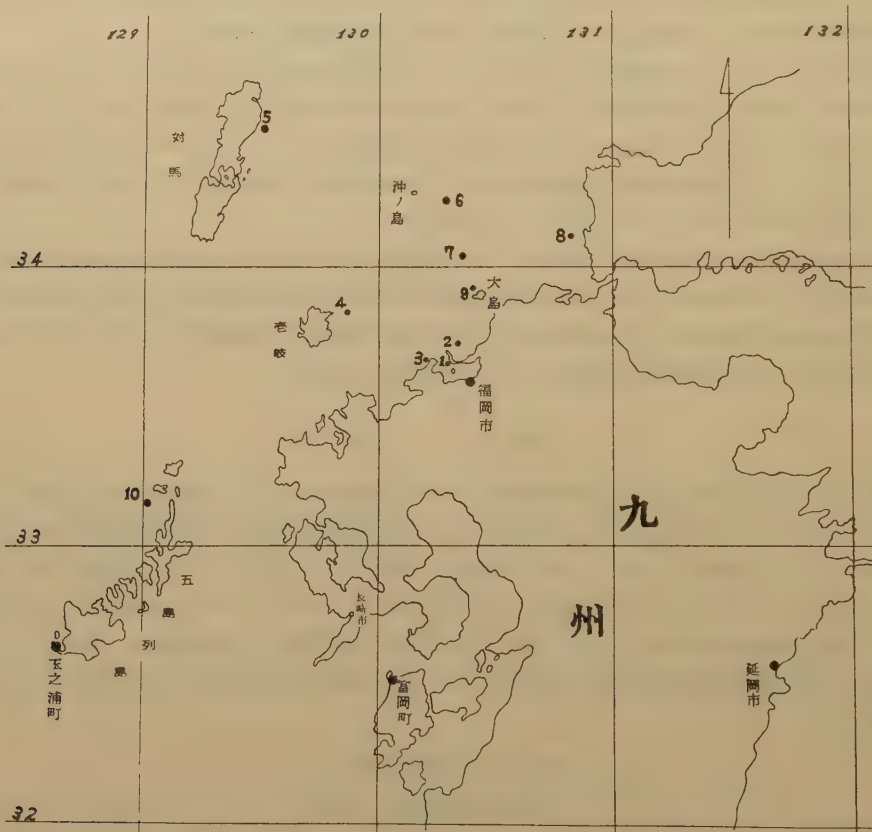
1) 九州大学農学部水産学教室業績。

2) 本研究の一部は文部省科学研究助成補助金及び農林省農林漁業技術試験研究補助金で行つた（内田恵太郎）。

3) 日本水産学会昭和 31 年度大会（昭 31 年 4 月：於東京）に於いて講演。

第1表. 浮游卵採集表

年 月 日	採 集 場 所	卵 数	表面海水温度℃
1951 XI—29	天 草, 富岡町 附 近	1	18.5
1953 II— 3	〃	1	13.5
II—10	〃	1	13.0
XII—16	延 岡 市 附 近	2	17.8
1954 I—19	〃	6	19.1
II— 9	〃	1	18.0
1955 II—11	五 島, 玉之浦町 附 近	5	15.5
III—15	〃	6	15.0



第1図. 浮游卵, 稚, 仔魚採集地点 (数字は第3表参照)

時の海水温度における孵化時間を知るために, 一部を 500 cc 標本瓶に入れて海中に吊し, 他は直径 22 cm, 深さ 10 cm のガラスの水鉢に入れ室内で飼育観察した. 当時の表面海水温度は 15.2~15.8℃, 室内飼育中の水温は 11.0~16.2℃ (13.0~15.0℃ の期間が最も長い) であった.

熟卵: 人工授精に用いた完熟卵は淡黄色の油球 1 個 (稀に 2~3 個に分離) を有する球

形分離浮性卵である。卵膜及び卵黄は無色で特殊な構造はなく、卵膜腔は狭い。卵径 1.35 ~ 1.44 mm, 油球径 0.35 ~ 0.38 mm であつた。天然浮游卵も同じような性質を持ち、卵径 1.22 ~ 1.45 mm, 油球径 0.34 ~ 0.38 mm であつた。

卵内発生：一般の浮性硬骨魚卵と大差はない。受精後 30 分で胚盤の形成が認められ、1 時間後には明瞭な隆起を形成し、2 時間 10 分後に第 1 分割が行われた (Fig. 1)。約 1 時間 10 分の間隔で第 2, 3, 4 分割が起り、10 時間後に Morula 期に達し (Fig. 2)、24 時間後に胚皮は卵黄の 1/3 を掩い、36 時間後には 2/3 を掩つて胚体原基が現われた (Fig. 4)。間もなく眼胞を生じ、胚皮は急速に卵黄を掩い、油球は胚体に対して反対側の卵黄表面に、一部突出して、固定される。胚体後部に脊索、筋節 3 ~ 4 個及び Kupffer 氏胞を生じ、色素胞の原基が胚体側の卵黄の半球面上に次いで胚体背面に泡沫状をなして現われた。40 時間後に胚孔を閉じ、油球周辺の卵黄上にも色素胞の原基が現われ、胚体背面のものは黒及び黄色素胞に分化をはじめた (Fig. 5)。48 時間後には卵黄上の色素胞の原基も黒及び黄色素胞に分化し、それぞれ胚体上及び油球表面へ移り、卵黄上には色素胞は殆んど見られなくなつた。耳囊が形成され、筋節数は 15 個数えられた。60 時間後に尾部が卵黄から離れ、Kupffer 氏胞は消失しはじめ、レンズ及び心臓の形成がはじまつた。胚体及び油球上に点状黒色素胞が密に分布し、筋節数は 22 個数えられた (Fig. 6)。80 時間後に胚体は卵黄のほぼ 3/5 をとりまき、黒色素胞の一部は樹枝状になり、体の背面と油球の内側表面 (胚体に面した側) とに分布し、黄色素胞は油球全表面と胚体側面とに見られた (Fig. 7)。やがて頭部周辺の卵黄上に孵化酵素腺と思われる泡状物が現われた。96 時間後に肛門が形成され、油球が卵黄の前端近くに位置していることが明瞭に認められた。胚体上の黒色素胞の一部は体側及び腹面へ移つた。30 個以上の筋節が数えられ、孵化酵素腺と思われるものは発達し、胚体はほぼ完成した (Fig. 8)。4.5 日 (108 時間) 後に孵化がはじまつたが、大部分のものは 5 日 (120 時間) 後に孵化した。孵化直前には胚体は卵内の $1\frac{1}{3}$ を周り、卵黄後方に数個の樹枝状の黒及び黄色素胞を生じた (Fig. 9)。卵は孵化するまで浮いていたものが多く、孵化直前になつて少数のものが器底に沈下した (比重 $\sigma_{15} = 1.025$)。孵出は頭部から行われ、孵化後の空殻はほぼ類円孔であつた。孵化酵素の作用は卵膜全体に及ぶと考えられるが、孵化後の空殻がほぼ一定の形をとり、且つ卵膜の破れた部分が卵黄上に存在していた孵化酵素腺と思われる粒状物の位置に大体対応しているのは注目すべきことである。1 月末の玉之浦町附近の天然海水温度 (表面水温 15.2 ~ 15.8 °C) では 4.0 ~ 4.5 日の間に孵化した。

孵 化 仔 魚

(Plate 10, figs. 10~12)

孵化直後の仔魚は油球を上にして表面に浮び、殆んど運動しない。全長 4.42 ~ 4.60 mm, 肛門は膜鰭を含めた体の 1/2 より後方に開き、油球は卵黄の前端又は前方下面に位置し、一部は卵黄表面から突出する。樹枝状又は点状の黒及び黄色素胞は油球全表面、卵黄後方及び直腸部に数個、頭部周辺から尾部中央部までの体の全面、そこから尾端までは体の背腹両面にのみ分布し、腹部前方と尾部前方との体側には前者に黒色素胞、後者に黄色素胞のやや顕著な集団が見られる。筋節数は $19 + 18 = 37$ (本種の脊椎骨数は $18 + 17 = 35$)

(Fig. 10).

孵化して 12 時間位経つと仔魚は頭を下にして容器の中層に懸垂静止し、その後は器底に下つて游泳する。

1 日後の仔魚は全長 4.85 ~ 5.08 mm, 眼に黒色素胞が現われ、胸鰭を生じてくる。黄色素胞は減少する傾向が見られるが、体側の黒色素胞は発達し、頭部周辺から尾部後方まで一面に拡がり、尾部後端では背腹に分れ尾端まで分布する。筋節数 その他に 変化はない (Fig. 11)。

2 日後に口が開きはじめ、胸鰭は大きくなり、卵黄下面にも黒色素胞を生ずる。3 日後に口は完全に開き、体の黄色素胞は数を減じて背腹両面に分れ、黒色素胞も数を減じて大きさを増す。肛門の位置や筋節数は変化しない。

5 日後に全長 5.0 ~ 5.25 mm に達するが、卵黄及び油球は吸収し尽されていない。眼に虹彩が現われてくる。黄色素胞はかなり減少し、黒色素胞も大型になり背腹両面に分れはじめる。筋節数や肛門の位置は変らない (Fig. 12)。

7 日後に卵黄及び油球を吸収し尽して死亡したが、全長その他に変化はなかつた。

仔, 稚 魚 期

(Plate 11, figs. 1~7)

本種の仔、稚魚に関しては千田氏 (1955) の報告がある。これらの内全長 4.0 mm 以下のものは、固定保存による体の縮小を考慮しても、ズキではないようである。図示された全長 4.0 mm のものは、筋節数 (16 + 19 = 35) と黒色素胞の排列とから、後述するタカノヘダイ類の仔魚ではないかと思われる。

本報告に用いた材料は、福岡県水試が 1951 年 (昭和 26 年) 以降行っている博多—対馬間の定点観測の採集物、対馬暖流開発調査の一環として行っている稚魚網による採集物及びシラス網其の他の漁具によつて混獲されたもの等である。これらの標本は、何れも、10 %ホルマリンで固定後 70 %アルコール中に保存したものである。体長は尾鰭を除いた長さを示し、尾鰭が形成途上にあるものは尾脊索末端までの長さで示した (第 2, 3 表)。

仔魚後期: 1) 全長 5.00 mm, 体長 4.75 mm (Fig. 1)。卵黄吸収後少時を経たものと推定される。孵化後 5 日の仔魚に比べて、黒色素胞は更に集まつて大型になり、特に頭

第 2 表. 記載各期測定表 (単位 mm)

記載 番号	全 長	体 長 (尾鰭を 除いた)	肛 門 ま での 長 さ	体 高 (腹鰭基 部の)	吻 長	眼 径	頭 長
1	5.00	4.75	2.78	0.55	0.23	0.31	0.84
2	6.48	6.18	3.40	0.88	0.44	0.44	1.47
3	8.34	8.04	5.52	1.22	0.65	0.55	2.10
4	11.16	9.94	6.64	1.72	0.90	0.72	2.88
5	13.70	11.96	7.80	2.30	1.10	0.98	3.76
6	18.12	15.22	9.86	3.48	1.44	1.40	5.22
7	25.90	21.38	13.52	5.52	2.02	2.18	7.30

第3表. 仔, 稚魚採集表

年 月 日	採 集 場 所 ¹⁾	全長範囲 mm	個体数	採 集 法
1950 III—19	5	11.16	1	稚魚網表層曳き
1951 III—13	不 明	9.62	1	〃
IV— 1	〃	9.84	1	〃
IV— 9	博 多 湾 奥	15.0—27.0	39	シ ラ ス 網
IV—24	博 多 湾 口	15.5—24.0	2	地 曳 網
1952 IV—19	1	9.62	1	稚魚網表層曳き
1953 II—10	3	8.39	1	〃
II—23	9	8.34	1	〃
III— 7	天 草, 福岡町 附近	13.5	1	〃
III—10	〃	14.0—15.0	3	〃
IV— 3	7	8.36—9.0	3	〃
IV—20	4	13.70	1	〃
IV—22	8	14.74	1	〃
1954 I—16	佐 渡 海 峡 ²⁾	6.47	1	〃
III— 6	6	5.00	1	〃
IV— 6	五 島, 玉之浦 海岸	18.12	1	タ モ 網
1955 III—16	10	13.36	1	稚魚網表層曳き
IV— 6	2	11.84	1	〃
IV—22	福 岡 市 海 岸	25.9—34.0	8	タ モ 網
V— 5	〃	43.0	1	〃
VI— 1	福岡市, 室見川河口	80.0	1	〃

1) 数字は第1図に示した場所に相当する(福岡県水試採集).

2) 日本海区水産研究所採集の標本. 採集位置: 138° 47' E, 37° 51' N.

部及び腹部にこの傾向が見られる. 尾部後端部には黒色素胞がないが, 他の部分の色素胞はあまり変らない. 腹部筋節数は正確には数えられないが, 尾部筋節数は17であつた. 肛門の位置は人工授精によつて得た仔魚と変らない.

2) 全長 6.48 mm, 体長 6.18 mm (Fig. 2). 頭部がやや発達するが, 体は細長い. 頭頂部の黒色素胞は下方に移る. 体の黒色素胞は再び小型になつて背腹両面に分れ, 体側には正中線上に胸鰭後方から尾部中央部近くまで, 間隔の開いた, 十数個が見られる. 体の背面の黒色素胞は胸鰭基底直上からはじまり, 肛門直上部までは膜鰭基底に1列, それから後ろ尾部中央部までは膜鰭基底を挟んで左右に分れ2列, 更に後方は再び膜鰭基底の1列を加えて3列になり, 最後から数えて3番目の筋節附近に終る. 腹面の黒色素胞は消化管下面に峡部から肛門まで1列, 腹腔上壁から尾部最後の筋節までは背面と似た排列を示す. すなはち, 腹腔上壁ではほぼ1列, 肛門から尾部中央附近までは膜鰭基底にある1列とそれを挟んだ左右の2列を加えた3列が密接して並び, それより後ろはこれらの3列が合して大きな色素胞となり巾広い1列を作る. 形成されはじめた尾鰭原基上に1個の樹枝状黒色素胞が見られる. 尾部筋節数は17.

3) 全長 8.34 mm, 体長 8.04 mm (Fig. 3). 吻端はやや尖り, 口裂は大きく, 主上顎骨後端は眼の中央下に達する. 前鰓蓋骨後縁に小さな2棘を生じ, 胸鰭に鰭条原基, 背,

臀鰭に鰭条基底 10 及び 11 個が現われ、脊索後端は上屈して尾下骨が形成され、尾鰭鰭条も現われてくる。鼻孔は単一の孔として眼の前方に認められる。吻端及び前鰓蓋骨下縁に 1~2 個の黒色素胞が見られる。胸鰭上方から尾部中央部附近までの体側正中線上に点状黒色素胞が 1 列に並ぶ。腹部前方背面の黒色素胞は数を減じて大型になり、胸鰭基底及び後縁直上部と腹部中央との背面に 1 個ずつ見られ、それから後ろの体の背面には背鰭基底後部までに、背面からやや離れて、約 10 個が弧状に並ぶ。背鰭基底部及びそれから後ろの黒色素胞は前の段階のものと大差はないが、後端部は膜鰭基底のものとそれを挟んだ左右のものとが合して巾広い 1 列になり、尾柄後端部に終る。腹面の黒色素胞も前の段階のものと大差ない。筋節数は $18+18=36$ 。

4) 全長 11.16 mm, 体長 9.94 mm (Fig. 4). 体は依然細長い。胸鰭及び臀鰭 (11 条で総数は定数) に鰭条が出現し、尾鰭には $8+7=15$ の鰭条が見られ、その内 6 本には軟条節が見られる。前鰓蓋骨後縁には 2 列の棘列が見られ、前列に 1 本後列には 3 本の小棘を具えている。頭頂部に再び小型の樹枝状黒色素胞が現われ、体側正中線上の点状黒色素胞は、各筋節にほぼ 1 個が、胸鰭基底直上から尾柄部まで見られ、後方のものは樹枝状を呈する。腹鰭は胸鰭下方に小突起として認められる。体の前部背面の黒色素胞が減少した以外に色素胞に変化はない。筋節数は $19+16=35$ 。

5) 全長 13.70 mm, 体長 11.96 mm (Fig. 5). 頭部がやや大きくなり、体形は成魚に似てくる。腹鰭を除く各鰭に鰭条が発達し、第 2 背鰭 17, 臀鰭 11, 尾鰭 $9+8=17$ ($7+6=13$ に軟条節が出現) 及び胸鰭に 15 条が認められた。前鰓蓋骨後縁の棘は前列に 5 個、後列に 8 個が認められた。体の背腹両面の黒色素胞は背、臀鰭基底から尾柄後部まで見られ、鰭の基底部では左右に分れて 2 列、尾柄部では左右合して巾の広い 1 列になり、体側の正中線上に 1 列に並んだ黒色素胞と共に本種、稚魚を特徴づける。頭頂部と尾部体側との黒色素胞は数を増すが、他の部分の黒色素胞には変化はない。

6) 全長 18.12 mm, 体長 15.22 mm (Fig. 6). 頭部は更に発達し、体は後方になるに従って細くなる。第 1 背鰭が縁辺に黒色素胞を伴って現われ、6 棘が数えられるが、第 2 背鰭とは連続していない。第 2 背鰭 4 棘 13 軟条、臀鰭 2 棘 10 軟条、腹鰭 6 条、胸鰭 16 条、尾鰭 $9+8=17$ ($5+5=10$ は先端が分枝) 軟条が認められた。頭頂部及び体側の黒色素胞は漸時増加し、体側正中線上のものは徐々に消失しはじめる。背、臀鰭基底から尾柄後端部まで存在する特徴ある黒色素胞は依然顕著で、背面のものは第 1 背鰭基底部まで見られる。消化管下面にあつた 1 列の黒色素胞は小点状になり、尾鰭下葉基底の 1 個の樹枝状胞も消失した。前鰓蓋骨後縁の棘列には変化はないが、新たに主鰓蓋骨上隅部と肩部とに 1 棘を生じた。鼻孔は前後 2 個に分れる。

後期仔魚末期: 7) 全長 25.90 mm, 体長 21.38 mm (Fig. 7). 体高を増し、形態は成魚にかなり近い。第 1 背鰭と第 2 背鰭とは連続し、9 棘と 4 棘 13 軟条が数えられ、総数は定数に達している。背、臀鰭基底から尾柄後端部附近までの体の背腹両面にある黒色素胞の外に、腹腔部を除く体の側面と頭部とに小さな黒色素胞が発達する。前鰓蓋骨後縁の棘は前列のものは小さくなり、後列のものも縮小しはじめる。肩部には数個の小棘が 1 列に並ぶ。体側に櫛鱗が現われ、側線も認められる。

生態: 成魚は外海や内湾の岸近くに棲息し、淡水域にも溯上する。磯波の打ち寄せる岩

礁性の海岸では、砕けた波によつて出来た白泡の中に好んで入り、このような所では大波のある日に、岸上から、擬餌を用いて釣る漁法が行われている。ブリ落とし網に入網した場合は、ブリやメジナ等と共に、最後の二重落としまで入る。

浮游卵から孵化した仔魚は卵黄吸収後浮游生活に入るものと思われるが、稚魚網の表層曳きによつて多量に採集されることはないようである。全長 15 mm 位になると岸近くに来游し、地曳網やシラス網等でイワシ類の稚魚と共に混獲されることが多い。この時期には潮溜りに入ることもあるし、汀附近を数尾の小群を作つて泳いでいることもある。30mm を越す個体はアジモ地帯や河口等に現われ、50 mm を越す個体は淡水域に溯上するようになる。その後は大体内湾や河口附近で生長するものと考えられる。なお、浮游末期から沿岸に来游する時期の食餌は、第4表にも示したように、主として小甲殻類特に橈脚類である。

第4表. 消化管内容物調査表

全 長 mm	消 化 管 内 容 物
13.5	Copepoda 4 個体
15.0	暗色塊状物少量, Copepoda 3 個体
16.5	Copepoda 破 片
18.0	空 虚
18.5	Alima 幼体 1 個体, Copepoda 破片
18.5	空 虚
20.0	〃
20.5	〃
21.0	Copepoda 破 片
33.5	Copepoda 約 150 個体, Mysis幼体 1 個体
34.0	暗色塊状物少量

ホルマリン固定保存による卵の変化

受精卵を 10% 海水ホルマリン液で固定保存した場合の変化は一般の浮性硬骨魚卵の場合と変らない。すなわち、卵径は殆んど変化せず、油球は崩壊するか径が変化し、黄色を呈する。卵膜腔は不変か又は大きくなるが、その度合は卵内発生の段階によつて著るしく異り、Gastrula 期から胚皮が卵黄の 2/3 を掩うまでの段階では卵黄の収縮が著るしい。油球の変化も卵内発生の段階によつて異り、発生初期の自由に卵黄内を移動し得る場合は変化することは少ないが、卵黄の特定の部位に固定され且つ一部が卵黄表面から突出するようになると、ホルマリン固定によつて、内容が卵黄内の他の部分にとび出し、その跡がほぼ完全な球形の空洞となり、2 個の油球を持つていように見えることがある。この場合油球上の黒色素胞（黄色素胞は固定により消失）は油球内容に移らず、空洞の内壁に残る。従つて、やゝ暗色で空虚な感を与え且つ色素胞を有する球形空洞と、黄色を呈し充実感のある油球内容とが離れて見られるわけである。

本種に類似した卵及び仔魚

九州近海に現われる本種に似た卵及び仔魚は、2 種が考えられる。その内の 1 種はタカ

ノハダイ属 *Goniistius* に属すると想像されるもので、浮游卵の主な出現期間は 10~12 月である。卵径及び油球径はスズキに比べて小さく、 $1.02 \sim 1.12 \text{ mm}$ 及び $0.25 \sim 0.27 \text{ mm}$ である。卵内発生はスズキに酷似しているが、黄色素胞が少ない。孵化直後の仔魚は全長 2.9 mm 、油球及び肛門の位置はスズキとほぼ同じであるが、筋節数は $16 \sim 17 + 20 = 36 \sim 37$ である。スズキに比べて黄色素胞に乏しいが、黒色素胞の状態は良く似ている。孵化後時間の経過と共に黒色素胞は体の腹面へ移り、卵黄及び油球を吸収し尽す頃になると、頭部から尾部後端近くまでの体の腹面に密な 1 列をなして並び、体の背面には尾部のみに見られ、体の側面には殆ど存在しない。卵黄吸収時の全長は 4.3 mm (スズキは $5.0 \sim 5.3 \text{ mm}$ 、何れも生時)。卵黄吸収後の仔魚期は、全長 6 mm 前後 (固定標本) までのものがスズキに似た形態を示し、全長 7 mm を越すものでは体高を増し容易に区別出来る。主な区別点は、黒色素胞が (1) 判然と背腹両面に分れて存在する。(2) 尾部体側正中線上に 1 列見られる。(3) 頭頂部に数個存在する。(4) 消化管下面に連続した 1 列がない等である。肛門の位置はスズキに比べて殆んど変らないが、筋節数は $17 + 19 = 36$ のものが多い。

他の一種はブリ *Seriola quinqueradiata* Temminck et Schlegel であるが、この卵及び仔魚は生時に観察すればスズキと混同する恐れはない。卵径 $1.23 \sim 1.27 \text{ mm}$ 、油球径 $0.3 \sim 0.33 \text{ mm}$ でスズキに比べてやや小さい。卵黄に亀裂を有し、孵化仔魚は膜鰭縁辺に黄色素胞を持ち、筋節数は $12 + 14 = 26$ である。固定した材料では黄色素胞が消失し、卵及び孵化仔魚をスズキから区別し得る多くの重要な形質が失われるので或は混同の恐れがあるかと思う。油球、肛門の位置及び黒色素胞の排列はかなりスズキに似ている。九州近海での産卵期は未だ十分知られていないが、スズキの末期とブリの初期とは重複する可能性がある。

なお、これらの卵及び仔魚期については別の機会に報告する。

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Résumé

Lateolabrax japonicus (Cuvier) is a common fish of Japan, sometimes ascending the river, attaining some 100 cm when full grown.

The author operated artificial insemination of this fish on January 29, 1955, at Tamanoura, Goto Islands, Nagasaki Prefecture, and observed the egg development and hatched larvae. On the one hand I found floating eggs and larvae of this fish in the catches of tow-net and other fishing gears operated in Kyushu.

According to the above mentioned catch records and the examination of the gonad condition of this fish, the spawning season seems to extended from November to March in Kyushu (Table 1, 3 and fig. 1).

The egg is bouyant, colorless and spherical in shape, measuring 1.35-1.44 mm in diameter with a single light yellow oil-globule (rarely divided into 2 or 3) measuring 0.34-0.38 mm in diameter.

The hatching took place in 4.5-5 days at the water temperature 11.0-16.2°C, and 4.0-4.5 days at 15.2-15.8°C (Plate 10, figs. 1-9).

The larva just hatched is 4.42-4.60 mm in total length, with the oil-globule situated in the anterior part of yolk, partly protruding from its surface. The myotome number is $19+18=37$ (vertebral number of this fish is $18+17=35$) (Fig. 10).

In a week the yolk and oil-globule was entirely consumed and reached 5.0-5.3 mm in total length. No remarkable change occurred during the course of yolk absorption (Fig. 11 and 12).

The larvae, 5-15 mm in total length (Plate 11, figs. 1-5), live a pelagic life in coastal region. The big post-larvae or juveniles about 20 mm or more in total length (Figs. 6 and 7), are found from the bottom near shore, in the zostera zone of estuaries or in the tide pools, chiefly feeding upon copepods or small larval crustaceans (Table 4).

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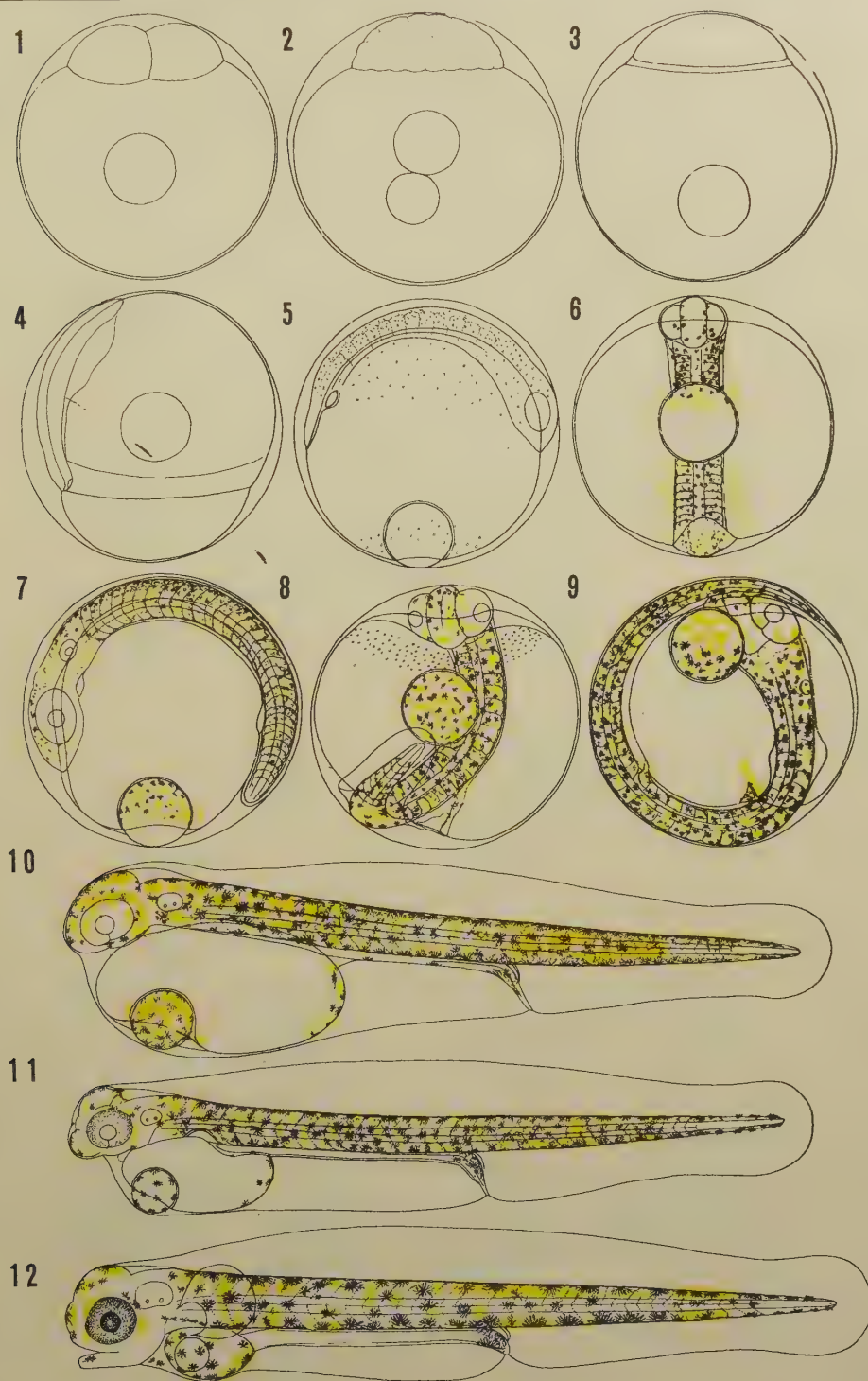
Explanation of Plates

Plate 10

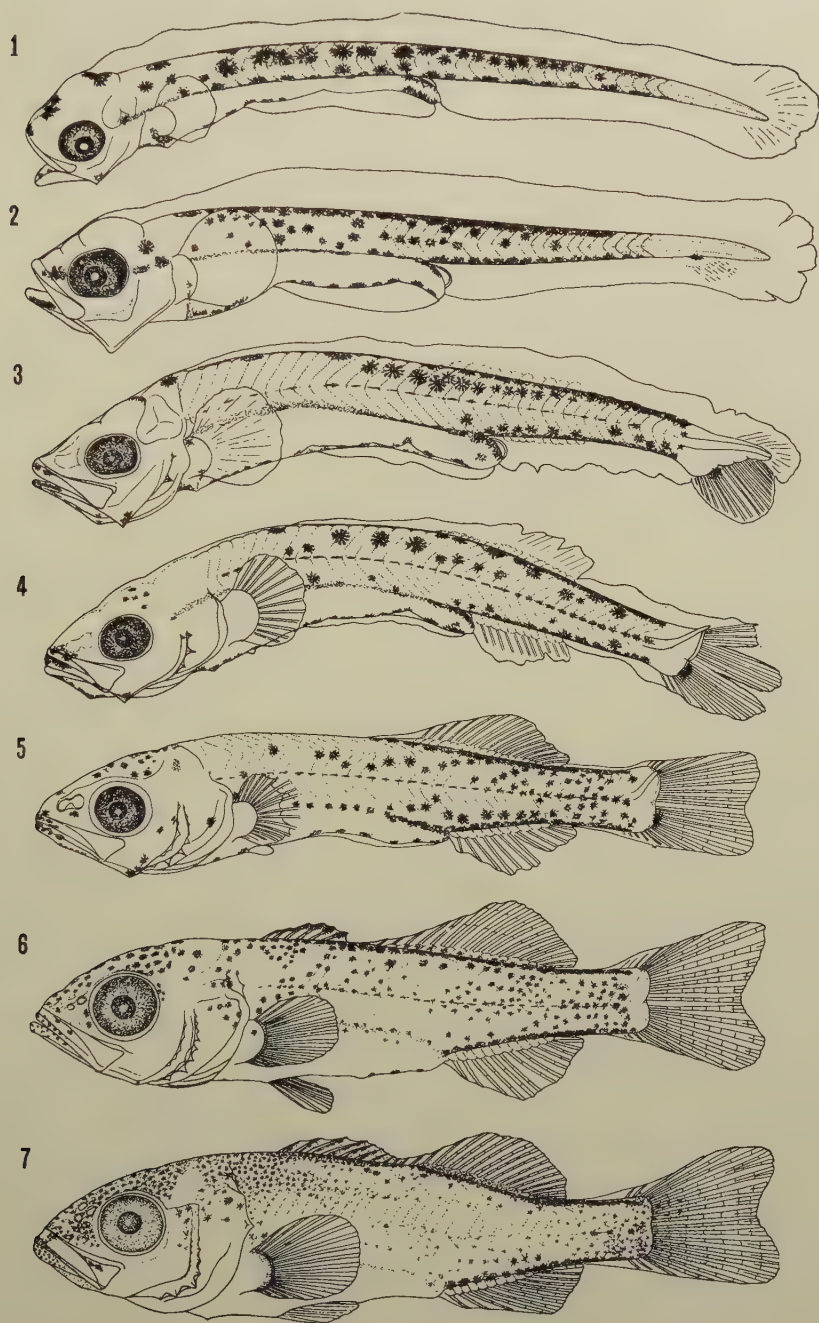
- Fig. 1. 2-cell stage, 2 hr. 10 min. after insemination.
- Fig. 2. Morula stage, 10 hr.
- Fig. 3. Blastula stage, 20 hr.
- Fig. 4. Formation of embryonal body, 36 hr.
- Fig. 5. 10-myotome stage, appearance of chromatophores (black and yellow), 40 hr.
- Fig. 6. 22-myotome stage, 60 hr.
- Fig. 7. 32-myotome stage, 80 hr.
- Fig. 8. Advanced embryo, with the hatching glands, 96 hr.
- Fig. 9. Just before hatching, 104 hr.
- Fig. 10. Larva just hatched, 4.50 mm in total length.
- Fig. 11. Larva 1 day old, 4.98 mm in total length.
- Fig. 12. Larva 5 days old, 5.13 mm in total length. (Drawn from alive specimen)

Plate 11

- Fig. 1. Post-larval stage, 5.00 mm in total length.
- Fig. 2. Post-larval stage, 6.48 mm in total length.
- Fig. 3. Post-larval stage, 8.34 mm in total length.
- Fig. 4. Post-larval stage, 11.16 mm in total length.
- Fig. 5. Post-larval stage, 13.70 mm in total length.
- Fig. 6. Post-larval stage, 18.12 mm in total length.
- Fig. 7. End of post-larval stage, 25.90 mm in total length.
(Drawn from preserved specimen)



スズキの卵発生と幼期



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ヒガンフグの卵発生と仔魚飼育

庄 島 洋 一

On the development of eggs and rearing of larvae of
a puffer, *Fugu (Higanfugu) pardalis*
(Temminck et Schlegel)

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ヒガンフグの卵発生と仔魚飼育¹⁾²⁾

庄　　島　　洋　　一

On the development of eggs and rearing of larvae of
a puffer, *Fugu (Higanfugu) pardalis*
(Temminck et Schlegel)³⁾

Yōichi Shōjima

I. は し が き

ヒガンフグ *Fugu pardalis* (Temminck et Schlegel) は北海道より沖縄本島にかけて見られる比較的小型の沿岸性のフグである。福岡市能古島では2月下旬より3月下旬にかけて漁獲される。

筆者は1955年春、福岡市姪浜市場に於いてすぐ近くの能古島の桝網で漁獲されて間もない活魚を用い、3月10日と3月25日の2回にわたって人工授精を行い、その卵発生を観察し、孵化した仔魚を約62日間にわたって実験室で止水飼育したので報告する。

この研究に当り終始懇切な御指導を賜わり、原稿を御校閲頂いた内田恵太郎教授に謹んで感謝の意を表する。

II. 産卵期・熟卵・孕卵数及び精子

産卵期 福岡市能古島に於ける1955年のヒガンフグの漁獲は例年とはほぼ同様な状態で2月24日より獲れ始め4月4日頃迄続いたが、生殖巣の状態からみて産卵期は3月中旬から同下旬に至る比較的短期間と考えられた。産卵は、その時期に漁獲されるのが岸近くの水深15m位の処に建ててある桝網に限られ、桝網ではこの時期以外には殆ど獲れないことからして、岸近くで行われると考えられるが、漁師によるとフグの多い時など岸から投網で獲つたと云うことであるから相当浅い所迄来ることが考えられる。

熟卵 卵は直径1.17~1.32 mm 平均1.24 mm⁴⁾ のほぼ球形をなした粘着卵で、厚くて透明な卵膜の全表面には他のフグ類で見られた如く網目をした波状の小皺がある。この卵膜を掩つて強粘着性の淡黄褐色半透明の粘質物層があり、卵内部の精査を困難にしている。卵黄は無色透明でその一端に多数の無色透明な小油球(直径0.008~0.036 mm)⁵⁾ が1群をなしている。本魚の未受精卵及び発生初期の卵の外観は淡黄白色半透明で、卵黄上面に小油

1) 九州大学農学部水産学教室業績。

2) この研究の1部は農林漁業技術試験研究補助金によつた(内田恵太郎)。

3) 本種は *Sphaeroides pardalis* (Temminck et Schlegel) とされていたものである(阿部, 1952)。

4) 全長288 mmの雌魚の卵4個, 全長236 mmの雌魚の卵40個, 計44個の卵を海水中に約2時間半放置した後測定した。

5) 64個測定。

球群があるため特にそこが白くなつて一見未成熟卵と思わせる。

孕卵数⁽¹⁾ 雌魚の孕卵数は Table 1 に示す如く左卵巢が右卵巢より多い。これらの卵は卵巢内で様な成熟状態を示しているのではほぼ同時に産卵されると考えられる。

Table 1. Number of the ovarian eggs.

Specimen No.	Total length	Body weight	Ovary weight		Number of ovarian eggs		Total
			left	right	left	right	
1	204 ^{mm}	200 ^g	13.20 ^g	12.70 ^g	18,600	17,500	36,100
2	224	255	23.50	16.50	33,000	22,500	55,500
3	264	430	46.40	40.10	48,800	42,200	91,000
4	265	400	48.85	38.10	53,600	43,200	96,800
5	310	—	88.40	62.10	96,400	70,400	166,800

精子 精子の大きさは全長 242 μ m, 体重 300 g の雄魚の場合全長 35~42 μ m, 頭部は 2~3 μ m である。

III. 人工授精及び卵発生

材料及び方法 人工授精には3月10日午前10時、姪浜魚市場に水揚げされてまだ生きていた全長 288 mm, 体重 630 g の雌魚と全長 296 mm, 体重 620 g の雄魚 (現場海水の比重 $\sigma_{15}=23.85$)、又3月25日は全長 236 mm, 体重 350 g の雌魚と全長 242 mm, 体重 300 g 及び全長 196 mm, 体重 150 g の2雄魚を用い (現場海水の水温 12.0°C, 比重 $\sigma_{15}=25.45$)、いずれも湿導法によつた。

卵はガラス片に附着させてガラス水槽中にて止水飼育したが、発生期間中の水温の変化に差をつけるため水槽の1部を室内に放置して温度変化を大きくすると共に1部はヒーター及び流水にて水温の変化を少くした。海水は約3箇月間汲置き、の自浄海水の他、採水後間もない海水も用い、1週間から2週間置きに全量を取換えた。

なお発生中の卵特にその初期の卵では表面の粘質物層のため内部の細部にわたる観察は困難だったので、針先で出来るだけこれを取除き検鏡した。

卵発生 (Plate 12) 卵は媒精後1時間50分で胚盤が隆起し始め、3時間半で完成して大きな胚盤が形成され (1)、5時間35分で2細胞期 (2)、8時間40分で4細胞期 (3)、11時間15分で8細胞期、12時間15分で16細胞期になる。24時間10分後で Morula 期 (4)、30時間10分後で Blastula 期、49時間35分後には Gastrula 期に達する。55時間15分後には Germ ring が認められ胚皮は卵黄径の約 1/2 を覆い、76時間20分後では殆ど全表面を包む。79時間50分後には胚体ができ始め、87時間55分後では原口は閉じ、胚体は油球群を2分する。93時間15分後には眼胞ができ始め (6)、120時間35分後には眼胞と胚体が粘質物層を透して明瞭に判る様になる。この頃より油球は次第に大きくなり、又卵黄上に小油球が小塊をなして散在してくる。125時間後には Kupffer 氏胞・脊索が現われ

6) 左右の卵巢内の成熟卵だけの重量を測り、その中から約 10% を秤量してその数を算え、これより算出した。

眼にはレンズができ始め筋節が 6 個数えられる (7)。1 週間後では筋節数は 15 に達し、レンズは明瞭に見られる。8 日後には耳囊が形成され桿状の小黒色胞が胚体に沿って卵黄上に現われるが、胚体上では耳囊附近に多い。尾部は卵黄より離れ時々動くのが見られる (8)。9 日後には Kupffer 氏胞消失し、耳囊後方の卵黄上に楕円形の胸鰭の原基ができ始めるが、ここには黒色素がなく以後黒色胞の発達に従って次第に顕著になる。体の動きが多くなり卵黄と共に卵内を 1/4 周することもある。10 日後に心臓が鼓動し始め (毎分 42~46 回) 眼も薄黒くなる。黒色胞はその数を増し又枝分れしてきたので粘質物層の外部より肉眼にて 2 筋の黒色胞列を認めることが出来る。11 日後に血流が見られ黒色胞は大きくなり互に連絡してくる。胚体には頭部にも現われるが、体側に多く、特に耳囊並びに尾部が卵黄と離れる附近に多い。卵黄上には黒色胞の他に黄緑色胞が少数現われる。胚体は卵黄をほぼ 3/4 周し狭い仔魚膜鰭を有する (9)。12 日後には耳石 2 個現われ心臓の鼓動は毎分 59~62 回と早くなり、13 日後には胸鰭の原基は小さい塊となつて盛り上りその後端は卵黄から離れる。顆粒状の構造が頭部及び眼上に少数現われてくるが、この頃になると同一水槽中での各卵の発生段階の差が目立つてくる。14 日後には眼は真黒となり又グアミンが現われて銀色に反射する様になる。胚体上には黒色胞が新たに吻端・耳囊上方背面に現われるが、後者はその後次第に顕著になる。時々胸鰭の動くのが見られる (10)。16 日後には顆粒状の構造は頭部全面に現われ胚体は卵黄を 1 周する。この頃になると黒い両眼と体側の 2 筋の黒線を卵外より肉眼で認め得る。17 日後の胚にはほぼ黒色胞と同位置に黄緑色胞が存在するが、特に眼の前後・胸鰭基部・耳囊附近に多い。筋節数 $9+15=24$ で囲卵腔には無色透明の粘液がある。19 日後には眼のグアミンは卵外より容易に認められ、油球は直径 0.029~0.063 mm の大きさになる。孵化前には胚は口を開き、グアミンは卵黄上面にも胚体に沿って多く認められるが、色素胞特に黒色胞は個体によつて発達の程度の差がかなり大きく見られた (11)。

水温及び比重の変化と卵の死亡 水温 11.0~17.0°C (A)⁷⁾ では受精後 21 日目に最初の孵化が行われ、引続いてその後 19 日間にわたつて孵化したが、全仔魚の 50% が孵化したのは受精後 29 日迄で、77% が孵化した 31 日後からは卵の死亡と共に孵化後 24 時間以内に死ぬ仔魚の数が増した。発生期間を通じて全卵の約 35% が死んだ。

水温 8.2~24.2°C (B)⁸⁾ では受精後 23 日目より孵化が始まりその後 16 日間続いたが 28 日後迄に全仔魚の 50%、31 日後迄に 93% が孵化した。発生中約 15% の卵が死んだ。

水温 12.2~24.0°C (C)⁹⁾ では受精後 20 日目より孵化が始まりその後 20 日間にわたつて孵化したが受精後 21 日迄に 50% 以上が孵化し 31 日後迄に 99% が孵化した。発生中に約 10% の卵が死んだ。

この卵発生実験と同時期に現地の能古島漁協が測定した海岸の水温は 10.0~15.0°C (日変化 2.7°C 以下) で水温経過は (A) に近いがそれよりも少し低く、海中に於いては (A) の場合よりも孵化が遅れることも考えられるが、実験は止水水中に於いて卵を外敵から保護

7) 流水にて温度変化を少くした場合、日変化 3.0°C 以下。

8) 受精後 4 日目より実験室内に放置し温度変化を大きくした場合、日変化最大 10.2°C。

9) 受精後 53 時間 30 分より電熱器で最低 14.5°C より下らぬ様にした場合、日変化 6.8°C 以下。

した状態で行つたものであり、実際海中に於いて孵化期間がこの様に長期にわたるか疑問である。(B)・(C)の場合孵化が(A)より比較的早く終り死卵の率も少いのは(A)に比べ卵数が少ないことも原因と考えられるが、発生後期・孵化期間の水温が(A)よりも高温であつたため水温の影響を示すものと思われる。

ヒガンフグ卵の海水の比重の変化に対する抵抗性は強く発生中に $\sigma_{15}=23.27\sim33.34$ の変化があつたが発生に特別な変化は見られず、 $33.34^{10)}$ の高鹹度でも孵化し 6 日間で 24.00 から 33.34 までの緩慢なる変化及び 33.34 から 25.12 への急変(受精後 27 日、水温 $19\rightarrow 18^{\circ}\text{C}$)でもその前後に死卵は見られなかつたことより、天然海水よりある程度高い比重の変化の影響は少ないと考えられる。

粘質物層の変化 卵は受精後 3 日過ぎても他物に附着し得たが、5 日後頃より次第に粘着性が弱まり 9 日後には殆ど附着しなくなつた。これより後は次第に粘質物層も弱まり所々破れて卵表面より剥げる様になつた。このため 2 週間後頃から卵は次第に透明になり、又水の動揺その他によつて附着基物から離れ易くなると共に表面に附着せる砂・ごみ等も脱落していつた。粘着性の強い本魚卵には海中では砂・ごみ等が附着することも考えられるので、本魚卵に媒精後直ちに汀の白砂(長径 $0.2\sim 0.7\text{ mm}$)を 1 卵平均 16 個及び 10.7 個附着させた 2 群の卵を、それらの附着していない卵と全く同様な条件で飼育比較したが、発生・孵化並びに死卵に関して明らかな差異は見られなかつた。

IV. 孵 化

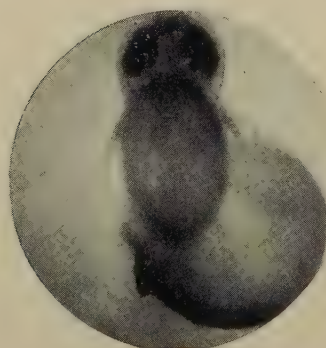


Fig. 1. Just hatching.

ヒガンフグ卵の孵出孔は破孔型(不整孔)に属し大部分の仔魚は頭部より孵化したが、仔魚 1813 尾中約 3% は尾部より孵化しかけたため、腹部の膨みに卵膜がひつかかり頭・腹部は卵膜内に残つた。この中 42% (25 尾) は多く 2 日から 5 日以内に死んだが、中にはこの状態を続けて 17 日後に死んだ例もある。残りの 58% (35 尾) の仔魚は水の動揺や体を左右に動かすことにより 3 日以内に卵膜がとれて生残つた。これら卵膜をかぶつた仔魚の出現は孵化時期に無関係に殆ど毎日少数ずつ見られたが、その生残る率は早期に現われた仔魚の方がよかつた。孵化時の鼓動は毎分 132 回

前後で、孵化は頭部を卵外へ出してから極く短時間(1 分以内)で行われた例が多いが、21 分(水温 20.0°C)、27 分(23.9°C)、29 分(19.0°C)を要した場合もあり、中には 7 時間 35 分以上(16.0°C) かかつた例もある。

卵から出た仔魚は体を包む卵腔の粘液物質を振り切る如く、激しく尾部を振りながらきりきり廻つて水面まで上る。

10) 以下 σ_{15} の数値を示す。

V. 仔・稚魚 (Plates 12~13)

仔魚前期 i) 孵化直後の仔魚 (12, 13) は全長 2.64~3.20 mm¹¹⁾ で、頭大きく眼黒く体全体はずんぐりし、筋節数 23~27 (成魚 9~10+13~14=22~23) で、肛門は体のほぼ中央第 9~10 筋節下に開く。小さな鰓孔の直後に団扇状の胸鰭があるが鰭条はまだない。仔魚膜鰭は胸鰭後方の第 5~6 筋節より始まり尾端を廻つて腹部後端に終るが尾端部を除き巾は狭い。腹部は卵黄を多量に有するため楕円形をなして大きく、表面には小油球があるが、腹側部を薄黒くしている黒色胞のために見難い。心臓は腹部の前下端にあり直腸の直後には膀胱が見られる。黒色胞は腹部のほか耳囊の所から眼の前後・吻端・頭頂・後頭部背面にかけて散在するが、特に胸鰭基部から腹腔背面・肛門後方にかけて多く、約 60% の仔魚は肛門後方の黒色胞群に対応する黒色胞がすでに背面に存在する¹²⁾ 黄緑色胞は腹部を除いてはほぼ黒色胞と同様な位置にあり眼の前後・後頭部に多く、特に腹部背面より肛門後方にかけて樹枝状に密在する。赤色胞は肛門上方の筋節上から上腹部にかけて少数点在する。グアニンは眼及び腹部上面に発達し銀白青色に見えるが密でない。(これらの色素胞特に黒色胞は個体によつて差が大きく、全体的に見て黒色胞の発達悪く比較的腹部の大きな色の白い仔魚と、それよりも腹部小さく色の黒い仔魚とがあり、前者は孵化時期の遅れる程多くなるが概して後者の方が元気がよい)。

水槽中では仔魚は尾部を激しく左右に振りその反動で頭部を細かく左右に動かしつつ活潑に泳ぎ廻り、少し泳いではちよつと止まる動作を繰返すが時々静止して頭より底へ沈む。多く水面をガラス水槽の縁に沿つて泳ぎ明るい方へ集まる。

ii) 孵化後 3 日になると頭部は余り動かさずに尾部を振つてすいすいと泳ぎ、器底や器壁についている何物かを食べる様な動作をし、水中を泳いでいる *Brine shrimp (Artemia sp.)* の nauplius 幼生を攻撃する行動を示すがまだ食べない。

iii) 孵化後 6 日目 (14) 全長 2.88~3.60 mm (平均 3.34 mm, 41 尾測定) 卵黄は殆どなくなるが油球が残る、鰓条が 6 条現われ下顎も発達して上顎とほぼ同長となる。全体的に色素胞発達し鰓蓋部に黒色胞現われ腹部は全面黒褐色となり腹下面の黒色胞は下顎先端の黒色胞¹³⁾と連絡する。黒色胞は特に肛門附近に多くそれに対応する背部の黒色胞群はすべての仔魚に見られる。黄緑色胞は下顎先端に現われる他は孵化直後と大差なく、赤色胞は肛門上方より鰓蓋上まで体側中央部に点在する。

仔魚は水槽中にほぼ一様に分散し、胸鰭と尾部だけを振つてすいすいと斜上方へ上つていくが、途中一時動作を停止し頭部を下にして垂直に下方へ沈み、その途中から再び斜上方へ泳ぐ運動を繰返す。水槽の側面へ手を近づけると明るい 1 所へ集まつていたのがぱつと分散する。

仔魚後期 iv) 孵化後 10 日目の仔魚は全長 3.10~3.78 mm (平均 3.30 mm, 14 尾測定) で、油球を吸収し尽し胸鰭に鰭条現われ、仔魚膜鰭には背鰭、臀鰭の輪廓を示す高ま

11) 平均 2.95 mm, 146 尾測定、以後記載される全長は特に断らない限りすべて同定前に測定した。

12) 背面に黒色胞のある仔魚全長 2.72~3.20 mm 平均 2.97 mm, 背面に黒色胞のない仔魚全長 2.64~3.12 mm 平均 2.93 mm。

13) 早い仔魚には孵化から 35 時間後に小黒色胞が下顎先端に現われている。

りが背部中央と肛門後方に見られ、下顎は上顎より僅かに長い。腹側部は中央が比較的黒色胞が少なく色が薄くなる。

仔魚は胸鰭と尾部を細かく動かして泳ぐが動作はより敏捷になる。

v) 孵化後 14 日、全長 3.67 mm の仔魚では肛門後方の黒色胞群が巾広く上下つながり、黄緑色胞は眼の前後、胸鰭の基部附近に多く、グアミンは眼の後方から腹部上面にかけて存在するが密でない。吻端は垂直となり、鼻孔が見られ、生体では腹腔上前部に鰾が鈍く銀色に認められる。

vi) 全長 4.25 mm になると仔魚膜鰭は大体背鰭・臀鰭・尾鰭の 3 部に分れるが、まだ狭く相互につながり鰭条はない。グアミンは腹部上面には密在するが眼後部では粗である。

vii) 全長 4.72 mm. 尾鰭は尾椎は真直でその下方に鰭条原基ができて始めているが背鰭・臀鰭にはまだ認められず、腹下面に小瘤状物現われ、尾柄部には前後に並んだ上下 2 列の小顆粒が少数見られる。生体は背面及び腹面は黒褐色で尾柄部は黒く体側中央部は黒色胞が粗で明るい萌黄色を呈している。黄緑色胞は腹下面を除き全身に分布する。耳囊は発達した色胞のために見えなくなるが、鰾は未だ胸鰭基部に鈍く銀色に認められる。

この大きさになると同一水槽内でも大小の差が著しくなり大形の仔魚が小形の仔魚を攻撃することもある。水槽中では胸鰭と尾鰭だけを用いて静止し又緩慢に泳ぐが、水槽底に倒立して器底を舐めるように泳ぐ動作はこの後も引続いて見られた。餌を摂る時は動いている Brine shrimp の幼生から数 mm 離れた所に静止し、狙が定まるとさつと出てこれを食べるが、不消化な Brine shrimp の卵殻を口に入れた時は直ちにこれを吐き出す。スポイトで吸上げようとする時は非常に敏捷に泳ぐ。

viii) 全長 5.44 mm (16, 17). 胸鰭 14 鰭条あり背鰭・臀鰭・尾鰭には鰭条原基が形成される。黒色胞は尾柄部で特に発達しそのほか口の周辺及び鰓蓋部より肛門前方にかけて小さく点在する。黒褐色の大型の色胞は頭頂・背面・腹側上部・腹下面等に密在し、グアミンは眼下部にも現われてくる。大きな鼻孔の周辺は未だ高まりは見られず白い。尾柄部にある上下 2 列の顆粒列は粗に背面と腹下面を通つて眼前部で上下が連絡し、鼻孔の上下及び下顎部に於いて左右の列が連絡する。

ix) 全長 6.44 mm (18). 背鰭 12 鰭条、臀鰭 9 鰭条ができ、尾鰭は尾椎が上屈しその下方に鰭条が出来かけているため下方に発達して歪尾形となる。鼻孔は全周縁にわたつてもり上るが特に上下の 2 箇所が著しい。

x) 全長 7.12 mm (19, 20). 尾鰭は 10 鰭条形成され尾椎と鰭条との間に 1 切込みがあるが、大体正尾形となり血管が分布する。グアミンは肛門上方より体側中部を通つて眼下前方に至る。鼻孔突出し上方より見るに周辺部の上下 2 箇所の発達のために啞鈴状となる。

xi) 全長 8.67 mm. 尾鰭には未だ上前部に尾椎が残っているが鰭条には 1~2 節が形成される。背鰭・臀鰭は尾鰭に比べ小さく、上下唇には粒状の構造が現われる。

生体は体側中部及び眼が銀色で瞳孔は青い。

xii) 全長 10.54 mm. 尾鰭には尾椎は見られないが上前端にその名残りの小さい高まりがあり、鰭条に 2~3 節が形成されると共に中部の数条に沿つて黄緑色胞が現われる。吻端部と尾柄部を除き皮膚全面に小瘤状物が密在し、又尾柄部の顆粒列は顕著になり鼻孔上下及び口の周辺では大小の顆粒が並ぶ。

生体では青い瞳孔の周りは黄色味を帯びている。

稚魚 xiii) 全長 12.24 mm (21). 尾鰭は中部 4 鰭条に 4 節が形成され、黄緑色胞の数を増すと共に黒色胞も各鰭条に沿って現われるが特に鰭の中部に多い。背鰭及び胸鰭にも鰭条に沿って小黒色胞が現われる。腹下面には未だ黒褐色胞が密在し、鼻孔も狭く咽鈴状をなして 2 箇になつていない。

VI. 飼 育

孵化した仔魚は 0~24 時間後までに孵化水槽より別の水槽へ移し止水飼育した。使用した容器は四角¹⁴⁾又は円形¹⁵⁾のガラス水槽とピーカー¹⁶⁾で実験室内に放置するほか電熱器・流水等で温度変化を少くし、水槽にはガラス蓋をして埃と水の蒸発を防いだ。海水は最初約 3 箇月間汲置き海水を用いたがその後は採水後間もない新しい海水を用い、多くは 1 週間から 2 週間置きに全量を取換えたり之を濾過して再び使用したが、1 週間以内でも必要に応じて随時取換えた (39 日間換水しなかつた水槽もある)。餌としては熱帯魚飼育に用いる Brine shrimp の乾燥卵より得た nauplius 幼生のみを用い、孵化 1 日後より遅くても 3 日後から与え始めた。飼育中はほぼ毎日 1 回主として午後に投餌し何時見ても水槽中に nauplius 幼生が相当多数見られるよう注意したが、実際に摂餌するのが見られたのは孵化 9 日後からであつた。

飼育中の水温及び比重の変化に対しては抵抗が強く主に 12.0~26.0°C の温度範囲で飼育したが、孵化直後の仔魚は水温 20.0°C から 14.0°C への急変でも死ぬことはなかつた。孵化後 2 時間から 1 日半の仔魚は水温 15.0~21.0°C では水面を泳ぐが、23.0°C ではその約 1/3 が底に沈み、8.8°C 及び 24.5°C では殆どが器底に横たわり、27.0~30.0°C になると全仔魚が沈んで殆ど動かなくなつたが、これを 1 時間 3.0°C の割で 21.0°C 迄下げても死ぬ仔魚はなかつた。

比重の変化に対しても甚だ強く、孵化直後の仔魚を $\sigma_{15}=30.00$ から 24.08¹⁷⁾ の海水中へ (水温 16.0°C)、又 24.00 から 21.10 の海水中に移してもそれによつて死ぬことはなく (14.0→16.2°C)、孵化後 2 日の仔魚は 21.07 から 19.06 (8.8→15.2°C) へ、又 10 日後のものは 24.00 から 30.70 迄の徐々な変化 (18.8~21.5°C, 10 日間) と 30.70 から 23.09 への急激な変化 (20.0°C) にも耐え得た。孵化後数日たつた仔魚は 24.46 から 16.50 への急激な変化の後、その中に放置すると、動作は緩漫となり多く水面近くに浮いて 10 日後に約 2% が生残つたが、この比重の急変後約 1 時間して 23.89 の海水中へ戻すと 15 分後に正常の動作に返つた。14 日後の仔魚は 24.46 の海水中より水道水中に約 30 分間入れた後これを 23.89 の海水中に移すと、最初は激しく痙攣した様子を示して泳ぐが約 7 時間 50 分後には正常の動作になつた。孵化後 20 日経過した仔魚は 31.23 から 23.81 への急変 (16.0°C) には異常は見られなかつたが、24.91 から 21.39 への急激な変化 (15.8°C) では殆ど死んだ。

14) 横 20.2 cm, 縦 22.1 cm, 深さ 29.5 cm.

15) 直径 23.2~30.1 cm, 深さ 11.7~18.8 cm.

16) 300~1000 cc.

17) 以下すべて σ_{15} の数値を示す.

以上よりヒガンフグの仔魚は比重の変化に対し抵抗性強く、短時間であると水道水から $\sigma_{15}=31.23$ の高鹹水迄生存できたが、概して海水より低い比重よりも高い方に抵抗が強い傾向が見られた。これを確かめるには更に実験数を多くする必要がある。

VII. 成 長

飼育日数と成長との関係を Fig. 3 に示す。仔魚は卵黄を吸収し尽す孵化後 7 日頃から大小の差がつき始め、12 日後頃よりその差は著しくなり、22 日後では同一水槽中で最大は全長 6.30 mm であるのに対し最小は全長 3.97 mm で、32 日後の他の水槽では 4.15～5.64 mm の差があつた (Fig. 2)。仔魚の死亡は 15 日後頃から急激に増加し、22 日後迄

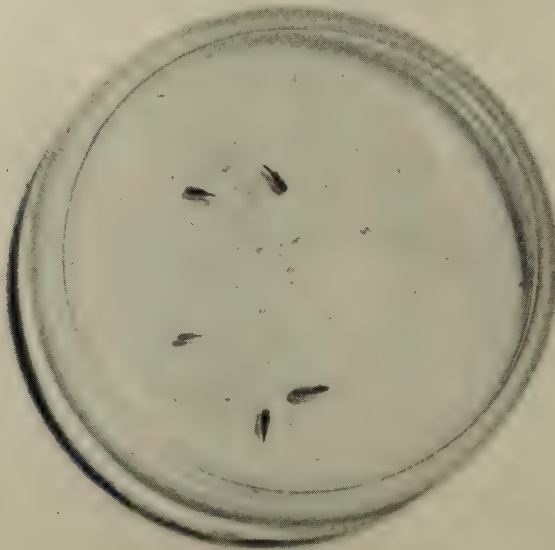


Fig. 2. Larvae 32 days old, including 1 swelled larva. X 1

に残る仔魚は水槽の大きさに関係せず 5～15% で、この時期に死ぬ仔魚は頭部のみ大きくて体は痩せ細り腹部は凹んで多く水底に横たわり又水面にも浮いていた。元気な仔魚は盛んに nauplius 幼生を食べて大きくなつていくのに反し、これらは餌はあつても食べなかつたものと思われるが、卵膜をかぶつた仔魚が 17 日間生延びた例もあり、水槽中では特別に餌はとらなくても孵化後 2 週間程生きられると考えられる。

最長 62 日間飼育出来たが最も成長のよかつた例は、水温 15～16.8°C で 50 日後に全長 13.09 mm の稚魚になつた¹⁸⁾。

18) 同年 6 月 19 日、福岡県糸島郡の海岸 (水温 25.5°C) で採集したヒガンフグの幼魚は全長 29～35 mm (固定後測定) であつた。

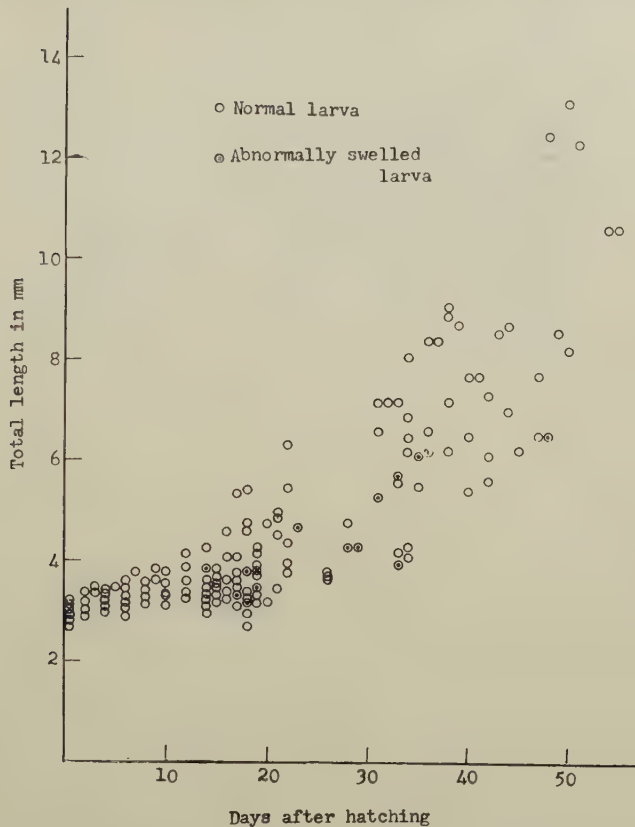


Fig. 3. Graph showing the growth of reared larvae.

VIII. 飼育中現われた異常形態を示す仔魚

本飼育実験中 Fig. 4 に示す如き異常な形態の仔魚が現われた。これらの仔魚の皮膚は程度の差はあるがいずれも全身にわたって膨れ上り、各鰭の基部・口の周辺及び鰓孔の所で深く内側へ凹んで色素胞のある内部の組織と接する以外は、体外方へ強く引かれた形状を呈する内部の組織から大きく離れ、甚だしくなると仔魚は恰も浮袋をつけた如くになって下へ沈もうとしても尾部から浮び上り水面近くにいることが多い。膨れた皮膚は顆粒状の構造を示し、黒色胞の附着している時もあるが多くは色胞はなく強靱で針先で突いても破れない。これらの仔魚は概して黒色より黄緑色が優り、又腹内部の消化器官が体外から観察出来たものもあつた。原因不明のこの異常な形態は全水槽の半数 14 の水槽中の、孵化 14 日後から 48 日後迄の仔魚に見られ、総数 25 尾に達したがこれはそれら水槽全仔魚の 4.2% に当る。水槽別には 13.6% から 1% 迄の変化があり、又同一水槽中では数個体が一度に現われたこともあれば全く別々に間を置いて現われたこともある。一度膨れたものが再び正常に戻ることはなく膨れが認められてから多くは 2 週間以内に死んだ、

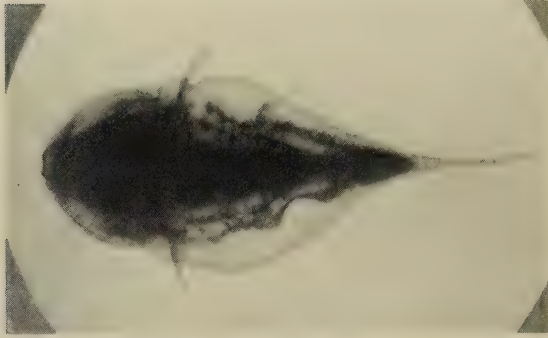


Fig. 4. Abnormally swelled larva, 4.27 mm in total length,
28 days after hatching.

IX. 摘 要

1. 福岡市能古島に於ける 1955 年のヒガンフグの産卵期は 3 月中・下旬で、成魚は岸近く集つて産卵すると思われた。人工授精は 3 月 10 日と 3 月 25 日とに行つた。

2. 卵は直径 1.17~1.32 mm のほぼ球形をなした粘着卵で、卵黄の一端には小油球群があり、厚い卵膜表面には網目をした波状の小皺がある。

3. 親魚孕卵数は 36,000~166,000 で一度に産出されと考えられる。

4. 卵は比重の変化に対し抵抗が強い。水槽中では水温 11.0~17.0°C で 21 日後より孵化が始まつたが、天然でもほぼこれに近い日数を要すると思われる。仔魚は多く頭部を先にして卵より出る。

5. 孵化直後の仔魚は全長 2.64~3.20 mm で黒色胞は頭頂・吻端・腹部・肛門後方等に発達し、黄緑色胞も腹部を除きほぼ同じ場所にある。

6. 仔魚は約 1 週間で卵黄を、10 日間で油球を吸収し終り、22 日後迄に約 5~15% が生残つた。

7. 仔魚の黒色胞は尾柄部に於いて特に発達し、黒褐色の色胞が背部・腹面等体の大部を占め、黄緑色胞は全身に分布する。

8. 餌としては熱帯魚飼育に用いる Brine shrimp (*Artemia*) の nauplius 幼生のみを与え、最長 62 日間飼育できたが成長の最もよかつた例は 50 日後に全長 13.09 mm の稚魚になつた。

9. 全長 12.24~13.09 mm の稚魚は吻の各側の鼻孔は未だ 2 箇にならず、背鰭・胸鰭・尾鰭に黒色胞があり、吻端部及び尾柄部を除く皮膚全面に小瘰状物がある。

10. 飼育中 Fig. 4 に示す如き異常に膨れた仔魚が現われた。これらは孵化後 2 週間から 7 週間の仔魚に見られ、一度膨れると元に戻らずに多く 2 週間以内に死んだがこの原因は不明である。

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Summary

Fugu pardalis (Temminck et Schlegel) is a common puffer in Japan, abundantly caught near shore in March. The artificial insemination of this fish was carried out on March 10 and March 25, 1955, at Meinohama, Fukuoka City, and the hatched larvae were reared in glass jars, fed only with the brine shrimp (*Artemia*) naupli.

The egg is demersal and strongly adhesive, and spherical in shape, measuring 1.17~1.32 mm in diameter. The yolk is light yellowish, with one cluster of small oil-globules, each measuring 0.008~0.036 mm in diameter. A wavy network pattern is observed on the surface of the egg membrane.

The fundamental process of development is much the same with the other teleostean eggs (Plate 12, 1~11).

Hatching took place from 21 to 40 days after insemination at the water temperature 11.0~17.0°C, and most of the larvae emerged from the egg head first (Fig. 1), although in a few cases the tail came first.

Newly hatched larvae (Plate 12, 12,13), measuring 2.64~3.20 mm in total length, with myotome number $9+10+13+18=23\sim27$, have large yolk sac, containing oil-globules. The melanophores were distributed on the head and yolk surface, especially on the anterior portion of the tail. Grass green pigment cells were found on similar places as the melanophores, except on the yolk surface. The larvae entirely consumed the yolk in a week, and the remained oil-globules in 10 days.

About 5~15 % of the reared larvae survived 3 weeks.

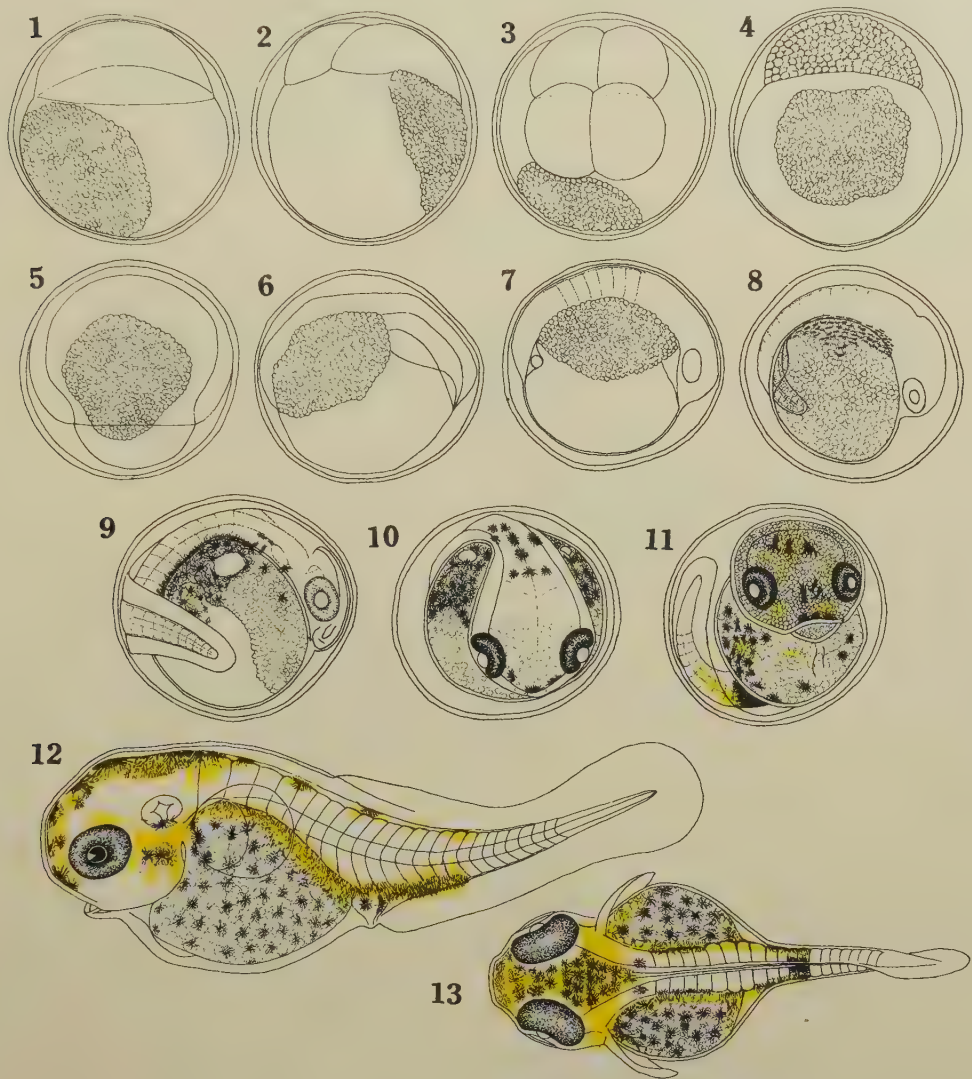
In 50 days after hatching, one of the reared larvae attained 13.09 mm in total length, with the small granules all over the skin except the snout and caudal peduncle.

Abnormal larvae (Fig. 4), with extraordinary swelled skin, were found from 2 to 7 weeks after hatching.

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Explanation of Plates 12~13

- 1) Blastodisc formation, 3 hrs. and 40 mins. after insemination.
- 2) 2 cell stage, 5 hrs. and 45 mins.
- 3) 4 cell stage, 8 hrs. and 40 mins.
- 4) Morula stage, 24 hrs. and 10 mins.
- 5) Blastoderm covers nearly $3/4$ of the yolk, 75 hrs. and 55 mins.
- 6) Rudiment of optic vesicles, 93 hrs. and 15 mins.
- 7) 6 myotome stage, Kupffer's vesicle appears, 125 hrs.
- 8) Otocysts and melanophores appear, 8 days.
- 9) Blood circulation begins, 11 days.
- 10) Grass green pigment cells appear on the yolk, and guanine appear on the black eyes, 14 days.
- 11) Immediately before hatching, mouth opens, 21 days.
- 12) Newly hatched larva, 2.84 mm in total length, and its dorsal view (13).
- 14) Larva 6 days old, almost consumed the yolk, 3.37 mm.
- 15) Dorsal view of a larva 1 week old.
- 16) Postlarva, 5.54 mm, rudiment of dorsal, anal and caudal fin rays.
- 17) Dorsal view of (16).
- 18) 6.44 mm, the end of vertebrae bends upwards.
- 19) Advanced postlarva, 7.12 mm, and its dorsal view (20).
- 21) Juvenile, melanophores appear on the pectoral, dorsal and caudal fin.



ヒガンフグの卵発生と仔魚飼育



アカカマス の 卵 発 生 と 仔 魚 前 期

庄 島 洋 一 ・ 藤 田 矢 郎 ・ 内 田 恵 太 郎

On the egg development and prelarval stages of a kind of
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アカカマスの卵発生と仔魚前期^{1,2)}

庄島 洋一・藤田 矢郎・内田恵太郎

On the egg development and prelarval stages of a kind of
barracuda, *Sphyraena pinguis* Günther

Yoichi Shojima, Shiro Fujita and Keitaro Uchida

は し が き

アカカマス *Sphyraena pinguis* Günther は東京附近から南日本にかけて分布し全長 350 mm に達するカマス科 Sphyraenidae の魚である。カマス科の魚の卵発生及び稚仔魚については Orton (1955) がカリフォルニア沿岸の *Sphyraena argentea* Girard について発表しているが、我国近海の魚については殆ど知られていない様である。筆者等は 1956 年 6 月中・下旬、福岡県行橋市蓑島において、罾網で獲れた直後のアカカマスを用いて人工授精を行い、その卵発生と仔魚前期について観察したので報告する。

この研究にあたり乗船の便宜を与えられた行橋市蓑島の磯辺紋一郎氏に深謝の意を表する。

産卵期・熟卵及び孕卵数

産卵期 1956 年の行橋市蓑島附近における本種の産卵盛期は 6 月中旬から 7 月中旬にわたつたものと考えられ、その間殆ど罾網で漁獲されていた。

熟卵 熟卵は径 0.69~0.82 mm³⁾ の球形(極く稀に長楕円形)をした分離浮性卵で、薄い透明な卵膜には特殊な構造はない。卵黄は無色透明で亀裂が著しく⁴⁾、径 0.18~0.21 mm⁵⁾ の無色乃至淡黄褐色の油球が 1 個(時には 2 個)あり、囲卵腔ははなはだ狭い。

孕卵数 成熟卵巣は柔らかく部分熟で、肛門部より前方に鰾の下を消化管を挟んで腹緒上前方に至り、その前端は肝臓又は幽門垂に接している。細長い卵巣の内部に透明な熟卵があり、その外側には径 0.20~0.44 mm⁶⁾ の淡黄色、不透明の成熟過程の卵と径 0.04~0.20 mm⁷⁾ の未熟卵が混在する。熟卵は成熟魚の腹部を軽く圧すだけで流出することより、漁撈中又は販売中での流失も考えられ、Table 1 の熟卵数は実際より少ない場合もあり得る

1) 九州大学農学部水産学教室業績, 日本水産学会九州支部秋期大会で講演(1956 年 9 月 23 日, 唐津)。

2) 本研究の一部は農林省農林漁業技術試験研究補助金で行つた。

3) 平均 0.75 mm. 人工授精に用いた全長 292 mm の雌魚の未受精卵を 4~5 時間海水中に放置した後 39 個測定。

4) フォルマリンで固定、保存している卵では卵黄は無透明となり亀裂も見難くなる。

5) 平均 0.19 mm. 1) と同じ卵を測定。

6) 7) フォルマリン固定後測定。

Table 1. Number of ovarian eggs.

Specimen No.	Total length (in mm)	Body weight (in grams)	Ovary weight (in grams)		Counted number of mature eggs			Calculated number of maturing eggs		
			left	right	left	right	total	left	right	total
1	267	110	5.5	4.7	—	—	10,661	76,000	77,000	153,000
2	268	107	4.0	3.1	0	0	0	90,000	73,000	163,000
3	270	108	5.2	3.1	2,012	163	2,175	104,000	61,000	165,000
4	273	109	4.8	3.9	0	0	0	94,000	73,000	167,000
5	278	109	5.1	3.8	4,072	3,518	7,590	93,000	52,000	145,000
6	280	117	6.8	6.0	6,144	4,920	11,064	—	99,000	—
7	280	119	4.5	4.2	2,757	2,380	5,137	93,000	77,000	170,000
8	282	109	4.7	4.1	0	0	0	89,000	74,000	163,000
9	288	143	7.9	4.9	—	—	17,352	95,000	68,000	163,000
10	296	131	5.6	5.0	—	—	7,843	84,000	72,000	156,000
11	306	156	6.5	4.3	2,020	470	2,490	87,000	58,000	145,000
12	342	225	8.0	6.8	0	0	0	164,000	135,000	299,000
13	366	285	8.0	7.2	0	0	0	193,000	164,000	357,000

Countings and calculations were made from preserved ovaries.

Preserved maturing eggs were 0.20—0.44 mm in diameter.

が、これらの熟卵が1度に産卵された後成熟過程の卵 Maturing egg が順次成熟し、何回かに分けて産出されると思われる。

人工授精及び卵発生

人工授精は6月18日、19日と27日の3度にわたつて前記養島の漁船上にて行つた。18, 19両日の実験では発生途中で死んだ卵が多く殆ど孵化しなかつたが、27日午前2時45分から4時50分の間に、沖桟網漁船上で漁獲直後の生きている成魚を用い、4回にわたつて⁸⁾ 乾導法により行つたものは正常に発生を続け孵化した。

発生中の卵は500~1,000 c.c. 広口瓶に入れ旅館の二階机上に放置し、発生期間中1~2回新鮮なる海水で換水した。

卵発生 (Plate 16, Figs. 1-8) 卵は媒精後55分で胚盤が見られ(Fig. 1), 2時間20分で16細胞, 3時間で32細胞, 4時間30分でMorula期に達する(Fig. 2)。8時間5分後にはGastrula期となり, Germ ringが認められ, それより50分後にはEmbryonic shieldが出来始め, 10時間20分後には胚皮は卵黄のほぼ半ばを覆うに至る。12時間後には胚皮は卵黄の大部分を覆い, 胚体原基認められ(Fig. 3), 原口は12時間35分後に閉じる。14時間後には眼胞出来始め, 脊索, Kupffer氏胞現われ, 筋節は8個。16時間45分後には眼胞明瞭に見られ, 耳囊出来始める。筋節は9~10個(Fig. 4)。19時間55分後にはレンズ出来始め, 筋節は18個になり, 胚は卵黄を半周するが尾部先端は未だ卵黄より離れない。胚, 卵黄, 油球上に点又は桿状の小有胞現われる。即ち胚では黒色胞は中脳後背部

8) 2時45分, 雌魚全長290 mm, 雄魚全長260 mm; 3時10分, 雌魚全長370 mm, 雄魚全長274 mm; 4時35分, 雌魚全長310 mm, 雄魚全長283 mm; 4時50分, 雌魚全長292 mm, 雄魚全長260 mm. 現湯水温21.3°C, 気温21.2°C.

を横切つて数個が並び更にその両端より後方背面に左右の列をなすが、これらの列は後脳を縁どつて互に近づき後脳後方より背面中央に近く2列に並び尾端近くまで分布する。後脳背面には黒色胞なく、それを取りまく黒色胞の三角形の配列⁹⁾はこの後孵化するまで認められた。黒色胞より多い黄色胞は眼胞の前後より体の両側に沿つて側面、腹面を後方へ分布し、尾端近くでは背面近くにも存在する。卵黄及び油球上にも黒色胞と黄色胞が若干散在する (Figs. 5-6)。22時間20分後には耳石1個認められ、尾端は卵黄より離れて僅かに伸長する。24時間後には尾部大いに伸長し、Kupffer 氏胞は消失し、心臓は鼓動し始める。各色胞は樹枝状に発達し、胚体上の黄色胞は眼の前後、耳嚢後方、尾部が卵黄より離れる前後及び尾端に近く互に離れて黒色胞より側方に背面、腹面に塊つて分布する。胚はしきりに動く様になる (Fig. 7)。更に孵化前には耳石が2個認められ、黒色胞は新たに尾端近くの腹面に少数現われるほか眼の上・前部、後脳背前部等に数個認められる胚もあり、黄色胞が吻端に見られる場合もある (Fig. 8)。¹⁰⁾

卵は水温 21.3~26.0°C の範囲で大部分受精後 24~30 時間の間に卵黄先端又は尾部より孵化した。

仔 魚 前 期 (Plate 16, Figs. 9-13)

孵化した仔魚は新鮮な海水¹¹⁾を入れた 500 cc. 広口瓶へ移して机上に放置し、飼育中に換水しなかつた。水温 22.2~28.5°C で仔魚前期の期間は 3~4 日間であつた。

孵化直後 (Figs. 9-10) (卵黄囊前端から尾端まで 1.75 mm, 吻端から尾端まで 1.62 mm) 仔魚は無色透明で亀裂の著しい¹²⁾ 卵黄を多量に有するため、楕円形の大きな卵黄囊の前端は吻端より突出し、油球はその前下方に位置する¹³⁾。口は開かず、眼に黒色素なく、胸鰭なく腸は細くて卵黄囊後方の筋節直下に位置し、直腸の直後に膀胱が見られる。仔魚膜鰭は後脳後方より始まり尾端を廻つて卵黄囊後端に終る。筋節数は 14+13=27 (成魚脊椎骨数 12+12=24) で、肛門は体の前方より約 2/3 の第 14 筋節下に開く。

黒色胞は中脳後方を横切り後脳を縁どる三角形の配列に引続いて、背面膜鰭基部を左右より挟み2列に並んで尾端に至り、若干は尾部の筋節側面及び尾端近くの腹面膜鰭基部に分布する。このほか吻端、眼上部、後脳背前部、消化管背面等に小黒色胞が存在する仔魚もある。卵黄には油球とその附近及び後端上方にも分布するが数は少なくほとんど無い場合もある。黄色胞は大きな色胞となつて眼の前・上・後部、中脳後部、卵黄の前・後端、油球附近に分布するが、特に後脳後方筋節の背面から側面、卵黄囊後方の第 7~8 筋節、直腸上後

9) Orton (1955) はこれを diagrammatic shield-like design と呼んでいる。Fig. 10 参照。

10) Orton (1955) が *S. argentea* の卵で観察した色胞の中、黄色胞は卵黄上を除いて大体アカカマスと似ているが、黒色胞は後脳を囲む三角形の配列を除き大いに異なる。Orton は *S. argentea* で最初背部及び尾部腹面近くに出来た黒色胞が発生と共に膜鰭上に移動してここに1列に並び、更にこれが孵化前になるといくつかの色胞が集つて大きな黒色胞となつて点在することをカマス類の特長として重視しているが、アカカマスではかゝることは見られなかつた。

11) $\sigma_{15}=23.32$, 420 cc Rocky tide pool の海水。

12) 固定した材料では不明。

13) *S. argentea* では後端にある。Orton (1955)。

方の第 14~18 筋 節の側面に著しい。

仔魚は水中では多く水面近くに仰向けになつて斜上方から殆ど垂直上方を向いて浮いており、時々尾部を振るほかは静止している。

孵化後 6 時間経つと卵黄嚢は大分小さくなつて底に沈む仔魚が多く、これより後は概して器底近くにいた。

14 時間後 (全長 1.89 mm) 卵黄嚢小さくなり吻端より僅かにひつこむ。各色胞は樹枝状に大きくなり黄色胞は直腸上後部の筋節に著しくなる。

24 時間後 (全長 2.29 mm) (Fig. 11) 卵黄は未だ亀裂著しく油球はその前端に突出し、仔魚膜鰭は中脳後部より始まり幅広くなるが、後脳の上から背前半の筋節と接する部分はふくらんで嚢状をなす¹⁴⁾。黑色胞は頭部では吻端、眼上部、中脳後部、後脳背前部等に 7~8 個見られるが、後脳を三角形に縁どる黑色胞は耳嚢上を除いてほとんどなくなり¹⁵⁾、それに続く背面でもその数が減じて各色胞の間隔が大きくなるが、卵黄上と共に特に消化管に沿つて多く現われる。黄色胞は頭部のほかは後脳後方の第 1~3 筋 節背面、卵黄嚢後方の第 6~7 筋 節の背・腹面と、直腸に沿つて分布するほかその上方の筋 節の背・腹面及びその後方の第 16~18 筋 節の背・腹面に見られ、卵黄ではその前端に分布する。

仔魚は多く器底近くにおり上を向いているが、少数は水底に倒立したり水面近くに仰向けになつたりしている。運動は敏捷になつてスポイトにて追うとすいすいと横の方へ逃れる。

39 時間後 (全長 2.55~2.75 mm) 小胸鰭が出来、黄色胞は吻端にて大きく発達すると共に両眼にも現われてくる。

45 時間後 (全長 2.35~2.70 mm) (Fig. 12) 卵黄は頭部より小さくなり、消化管は前方へ伸び、吻端は少し突出する。耳嚢はやや大きくなり、体の両側に数対の Sensory organ が見られ、膜鰭の基部に於けるふくらみは最も発達して基部の全縁にわたる。筋 節数 13+11=24。

黑色胞は頭部においてその数を減じ吻端、眼上部、頭頂等に数個分布するほか、腹部の筋 節の背面には殆ど見られず第 7 筋 節の背面に 1~2 個あるだけであるが、腹面には前方より消化管に沿つて特に著しく存在する。尾部筋 節においてはその前半では背面に多くて腹面に少ないが、尾端では逆に腹面に多い。黄色胞は胸鰭基部に新たに認められるほかは前と大差ないが、背面の黄色胞は柱状又は樹枝状となつて膜鰭内へ拡がる。

50 時間後 (全長 2.70 mm) 口開き始めるも小さく、眼は前方より薄黒くなり始める。消化管は頭部へ伸長し、吻端の黑色胞は大きく目立つてくる。

66 時間後 (全長 2.96 mm) (Fig. 13) 卵黄、油球共に小さく存在し、耳嚢は大きく発達する。Sensory organ は頭部では眼の前後に各 1 対あり、体側には 4 対認められる。両眼は大分黒くなり黄色胞のほかにグアニンも少し認められる。血液循環は明瞭に見られ、大きくなつた胸鰭の基部後方に鰓が現われる。

黑色胞は頭部に於いて消えかかり未だ吻端、後脳前部、眼上部等に数個存在する仔魚も

14) Subdermal space. Shelbourne, J. E. (1956).

15) *S. argentea* では仔魚後期まで残る。Orton (1955).

あるが既に消失した個体も見られる。体背面においては前と大差なく腹部中央第7筋節に1個、直腸上方の第11~14筋節に4個、尾部では第17~19筋節に3個の大きな黒色胞が存在するが、尾端部では背面1個に対し腹面には5個が並ぶ。尾部の17~19筋節腹面に2個存在するがこれらはいずれも後期仔魚まで残る。太くなつた消化管に沿つては特に多く、消化管の腹面には前部と肛門附近を除いては認められないが、その背面には鰾より前方から直腸部まで分布する。黄色胞は頭頂、後脳後部、眼後部、下顎、喉部等に小さく分布するほか、尾端部と肛門近くを除いては大体黒色胞と同様に分布し、特に腸管において著しい。

72~79時間後(全長2.52~2.72mm)から卵黄は無くなり油球が残つたが、これも84時間後頃(全長2.84mm)から無くなつた。90時間後には両眼真黒となり、膜鰭基部のふくらはきは背部前半のみとなつた。

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S u m m a r y

Sphyræna pinguis Günther is a common barracuda of southern Japan. It attains about 350 mm in total length when full grown. The spawning season seemed to extend from the middle of June to the middle of July, 1956, in the vicinity of Yukuhashi City, Kyushu.

The authors operated artificial insemination of this fish on June 27, 1956, at Minoshima, Yukuhashi City, Kyushu, and observed the egg development and hatched larvae.

The egg is pelagic, spherical in shape, measuring 0.69—0.82 mm in diameter. The yolk is colorless, transparent and very clear alveolar structure was observed in life, with a single oil-globule, colorless or very pale dull yellow, measuring 0.18—0.21 mm in diameter.

The fundamental process of embryonic development is much the same with other teleostean eggs (Plate 16, Figs. 1—8).

The hatching took place in about 24—30 hours after insemination, at the water temperature 21.3—26.0 °C, when the embryonic development was as the Fig. 8.

The newly hatched larva (Figs. 9—10) is 1.75 mm in length from anterior edge of yolk sac to end of caudal fin, with a oil-globule situated in the anterior

part of large ovoid yolk sac. The myotome number is $14+13=27$ (vertebral number of this fish is $12+12=24$). The melanophores are abundant along the dorsal base, and form a triangular pattern on the neck, leaving the area above the hind brain free from pigment. The larvae in glass jars were hanging under water surface on their backs.

The triangular pattern on the neck broke up in 24 hours after hatching. Small pectoral fins were formed in 39 hours.

In 45 hours (Fig. 12), the yolk was reduced to a globular mass smaller than the head, the snout slightly projected, and the subdermal space developed most extensively along the bases of dorsal and anal membranous fin. The melanophores became scarce on the head and dorsal surface of trunk, but abundant on the gut. Yellowish blotches were found on the head and body.

In 50 hours, the mouth opened. In 66 hours, the eyes were lightly pigmented, the air bladder became visible, and the filaments of sensory organs were found on the head (2 pairs) and body sides (4 pairs).

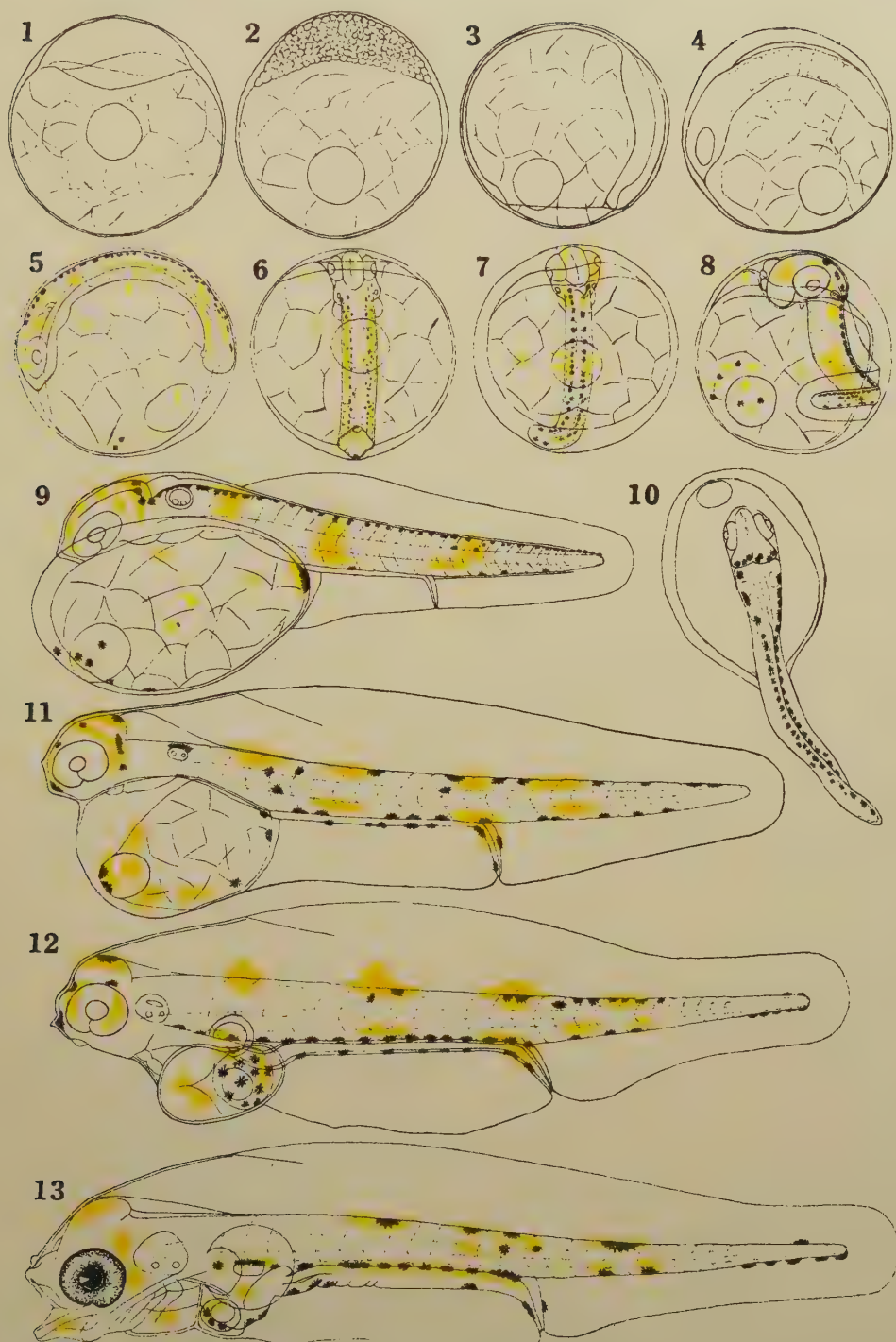
In 72–79 hours, at the water temperature $22.2-28.5^{\circ}\text{C}$, the larvae attained 2.52–2.72 mm in total length, entirely consuming the yolk.

Fisheries Laboratory, Faculty of Agriculture,
Kyushu University

Explanation of Plate 16

- Fig. 1. Blastodisc formation, 55 min. after insemination.
- Fig. 2. Morula stage, 4 hr. and 30 min.
- Fig. 3. Embryonic body formation, shortly before the closure of blastopore, 12 hr.
- Fig. 4. Nine myotome stage, eye vesicle formation, appearance of Kupffer's vesicle, 16 hr. and 45 min.
- Fig. 5. Eighteen myotome stage, lens formation, appearance of melanophores and xanthophores, 19 hr. and 55 min.
- Fig. 6. Ventral view of Fig. 5.
- Fig. 7. Heart begins to beat, disappearance of Kupffer's vesicle, 24 hr.
- Fig. 8. Embryo just before hatching.
- Fig. 9. Newly hatched larva, 1.75 mm in length from anterior edge of yolk-sac to end of caudal fin.
- Fig. 10. Dorsal view of Fig. 9.
- Fig. 11. Larva 24 hrs old, 2.29 mm in total length.
- Fig. 12. Larva 45 hrs old, 2.55 mm in total length.
- Fig. 13. Advanced prelarva, 66 hrs old, 2.96 mm in total length.

These figures are made from live samples except Fig. 10 which was drawn from preserved material in formalin.



アカカマズの卵発生と仔魚前期

天草におけるトビウオ類の研究

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天草におけるトビウオ類の研究¹⁾

第2報 バショウトビウオ *Parexocoetus mento*
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The life history and habits of *Parexocoetus mento*
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Hiroshi Tsukahara and Tsukasa Shiokawa

天草西海岸における我々のトビウオ類の調査で、トビウオ類の成魚は5種出現するが、このうちバショウトビウオ *Parexocoetus mento* (C. & V.) は全長 14 cm 内外の小形のものである。成魚は毎年5月中旬より9月下旬まで比較的長い期間出現し、その稚魚・未成魚も7月始めより10月終りまで現れるが、この地方では漁獲の対象となる程量的に多くない。本種に関する研究は、今井(1955)が成魚及び稚仔について一部記載しているにすぎない。外国でも Hildebrand and Cable (1930) 及び Breder (1938) が、大西洋産の *Parexocoetus* 属の2種についてその稚魚の形態を明らかにしているのみで、本属に関する資料は乏しい。筆者等は天草における重要魚類の資源生物学的研究を行いつつあるが、その間に本種の成長過程の資料の採取及び人工受精と仔魚の飼育を行い、その生態・生活史の概要を明らかにすることが出来たのでここに報告する。

はじめにこの研究に当り、御指導を頂き本稿の御校閲を賜った九州大学、内田恵太郎、相川広秋両教授、並びに種々御教示下さった鹿児島大学、今井貞彦助教授に厚く御礼申しあげ、又採集調査に尽力された天草臨海実験所の職員各位及び稲尾正氏に感謝する。

この研究はすべて天草臨海実験所において行い、資料の採集及び生態調査には実験所所属のおおしま丸(7.1 吨)・はやさき丸(1 吨)を用いた。採集は実験所の西海岸の数哩の沖合で、夜間集魚灯下に集まった成魚から稚仔魚までのいろいろの段階のものを、船上からたも網で掬い、同時に稚魚網の表面採集も行つた。

本種の分布については、薩南海域で今井(1955)が報告しているが、本邦における分布の詳細は明らかでない。一般に九州中部以南に広く分布していると考えられる。

1. 成 魚 の 形 態

本種は普通全長 10~150 mm 位にしか達しない小形のトビウオである。体は細長くてよく側扁し、眼はやや大きく、下顎端は上顎端よりやや前方に突出する。背鰭は著しく高

1) 九州大学農学部水産学教室業績及び九州大学理学部附属天草臨海実験所業績 No. 96.

2) 日本水産学会秋期大会(広島, 1956年10月)にて発表。

く、その色彩は青色をおびた黒色で、胸鰭は他のトビウオ類に較べてやや短かく、その先端は背鰭基底のほぼ中央に達するのみで、その上部はやや青味をおびた淡黒色で、腹鰭は小さく、生時には淡黄色をおびた灰色の、いわゆる単葉のトビウオである。体の背部は銀白色の光沢をおびた濃青色で、体側中央よりやや上方に濃青色の縦帯が走り、生時には体側が淡い黄色をおび、腹部は銀白色を呈している (Fig. 1).

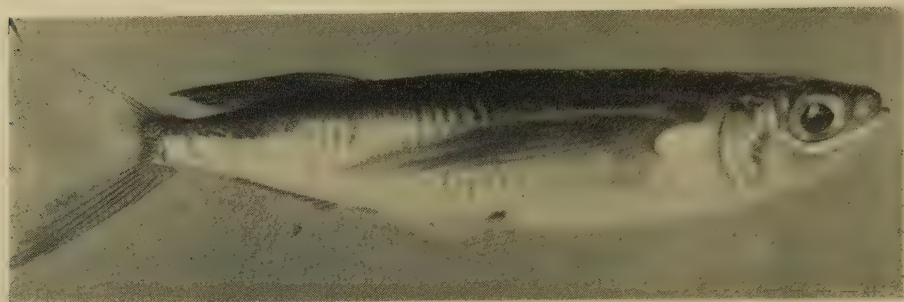


Fig. 1. Adult of *Parexocoetus mento*. Fork length 12 cm.

脊椎骨数 (尾叉骨も含む) はトビウオ類のうち最も少くて、35~36 (大部分 36)。背鰭軟条数は 9~10。臀鰭軟条数は 11~12。胸鰭軟条数は 14~15。体長 (Standard length) を 100 とした体各部 (10 尾 平均) は、体高 21.2, 体幅 13.4, 頭長 24.1, 吻長 6.2, 眼径 7.8, 眼隔 8.7, 吻端より胸鰭起部までの長さ 24.7, 吻端より腹鰭起部までの長さ 52.2, 吻端より背鰭起部までの長さ 68.1, 吻端より臀鰭起部までの長さ 72.5, 胸鰭々条の最長 54.1, 腹鰭々条の最長 20.5, 背鰭々条の最長 24.8, 臀鰭々条の最長 9.4, 背鰭基底長 17.2, 臀鰭基底長 15.8, 尾柄長 7.8, 尾柄高 7.1 (Table 1)。雌魚は雄魚に比してやや大形になる。

2. 一 般 生 態

この水域での成魚の出現は、5 月中旬に始まり、9 月下旬に終るが、その殆んど個体の生殖巣がほぼ成熟ないしは完熟していることにより、南方海域より産卵のため来游するものであろう。採集した成魚 54 尾について、その雌雄比を見るに、雄魚 45 尾に対し雌魚 9 尾で、雄魚が雌魚に比して極めて多く、この水域に出現の始めより終りまで、常に雄魚が多かった。

本種の昼間の生態の観察はすることが出来なかつたが、夜間集魚灯下の観察では、灯下に集まる習性を示し、群をなすことなく、胸鰭の両翼を挙げて極めて表面を游泳して灯下に集まる。灯下では胸鰭を張つたままほぼ静止状態で、容易にたも網で船上から採集することが出来る。夜間での空中を飛ぶ距離は 2,30 m 程度である。

胃の内容物よりその食性を調べるに、橈脚類、裂脚類、端脚類等の小形の甲殻類を食餌としているが、多くの場合胃の内容物は殆んど消化しつくされて、僅かにその断片をとどめているにすぎない。その雌雄比は 54 個体の成魚について、雄魚 45 尾に対し雌魚 9 尾で、雄魚が雌魚に比して極めて多い。

Table 1. Counts and measurements of *Parexocoetus mento*.

No. of fish	1	2	3	4	5	6	7	8	9	10
Total length (mm)	133	135	135	136	138	145	146	146	147	149
Fork length	116	115	115	117	120	122	121	123	125	126
Standard length	112	111	112	114	115	117	116	118	119	121
Body weight (g)	21.0	19.5	18.5	20.8	18.5	24.7	23.0	23.0	26.1	30.0
Sex	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
Gonad weight (g)	3.8	0.4	0.6	1.3	0.6	2.6	2.4	3.8	5.2	6.5
Number of vertebrae	35	35	36	36	36	36	36	36	36	36
Dorsal rays	10	10	9	10	10	10	10	10	9	10
Anal rays	11	11	11	11	11	11	12	11	12	11
Pectoral rays	15	15	14	15	15	15	14	14	14	14
Ventral rays	6	6	6	6	6	6	6	6	6	6
Predorsal scales	20	20	21	20	20	19	20	19	18	21
Postdorsal scales	37	38	38	39	38	40	39	37	38	39
Gill-rakers	7+19	8+19	6+20	8+20	8+20	7+19	7+19	7+20	7+20	7+19
Depth	23	23	23	23	25	26	24	24	28	26
Width	13	14	12	14	15	16	16	17	20	20
Prepectoral length	26	29	27	30	29	27	28	27	30	30
Predorsal length	58	58	58	60	60	62	61	62	62	63
Preventral length	75	77	76	78	79	82	79	79	84	84
Preanal length	81	82	81	81	81	87	88	88	86	87
Head length	26	26	26	27	29	28	29	28	28	29
Snout length	6	7	7	7	7	7	8	7	7	8
Eye length	9	9	8	9	9	8	10	9	9	10
Interorbital width	10	11	9	9	11	10	10	10	10	10
Pectoral-fin length	62	62	62	59	65	68	62	60	62	64
Ventral-fin length	24	22	24	23	25	26	22	23	23	25
Dorsal-fin length	26	28	28	28	29	30	29	28	29	31
Anal-fin length	11	12	11	12	12	13	12	12	13	14
Caudal-peduncle length	8	8	8	8	8	8	8	8	9	9
Caudal-peduncle depth	9	8	10	9	10	9	9	8	10	8

(July, 1955)

3. 産 卵

成魚の生殖巣の成熟状態と仔稚魚の出現状況より、この水域での産卵は5月より9月に亘って行われ、その盛期は6・7月と推定される。又7月上旬には、この水域にやや大形の稚魚が出現するが、これは南方海域では既に3・4月頃に産卵が行われて、その稚魚が成長しつつ対馬暖流によつて運ばれて来たものであろう。

卵の性質及び抱卵数：卵は球形の纏絡卵で、卵径 1.75~1.78 mm、卵膜は無色透明で、囲卵腔は狭く、卵黄は極めて淡い琥珀色を有し、卵の表面には長さが卵径の2~4倍程度の20本内外の細くて柔軟な纏絡糸が、ほぼ全面に均等に分布する (Fig. 2, 3 A)。



Fig. 2. Eggs, stripped and inseminated. $\times 10$

卵巣内の抱卵数は約 1,000~2,000 個で、完熟以外の卵粒は極めて小さく、その年内に産卵されるものとは思われず、産卵は 1 回に行われるものであろう。卵巣内の卵は全面に纏絡糸が覆い (Fig. 3 B), 海水中に出ると同時に纏絡糸がはぐれて他物に纏絡する。天然では海藻その他の基質に産みつけられるのであろうが、天然に産みつけられた卵は採集出来なかった。

人工受精及び卵内発生: 1955 年 5 月 28 日 午前 0 時 45 分 (水温 20.5°C) にトビウオ流刺網操業中、灯下に来遊した全長 147 mm, 体重 26 g の雌魚と、全長 135 mm, 体重 19.5 g の雄魚を用いて、直ちに船上で乾導法にて人工受精を行い、受精卵は実験室に持ち帰つて、流水 (水温 $21\sim 25^{\circ}\text{C}$) にて飼育観察した。孵化後の仔魚には、飼料として観賞用熱帯魚の飼育に用いられる Brine shrimp (*Artemia*) の幼生を与え、孵化後 16 日間 (水温 $24\sim 26^{\circ}\text{C}$) 飼育した。

卵内発生の経過は、他のトビウオ類と比較して特別の差異は認められない。受精後 1 時間 30 分で 4 細胞期、約 8 時間で桑実期、20 時間で胞胚期、約 1.5 日で胚体を形成する。胚体は淡黄色をおび、眼胞及び Kupffer 氏胞を生ずる (Fig. 3 C)。2.5 日で聴胞を生じ、筋肉節数は 17、3 日で胚体及び眼胞に褐色の色素胞を生じ、心臓の鼓動及び胚体の律動が認められる。4 日で胚体及び卵黄上に黄・褐・黒色胞が顕著に生じ、筋肉節数は 30 に達し、血液循環が顕著になる。7 日で胚体は黄色をおびた赤褐色となり、筋肉節は定数に達し、胸鰭が生じてそれを活潑に動かすようになるとともに、体の律動も活潑になる (Fig. 3 D)。受精後約 10.5 日で孵化を始め、すべて尾部より孵出する。孵出は必ず夜間に行われ、日没後 1~3 時間の間が最も多い。昼間は全く行われませんが、昼間でも暗所に置くと数時間後に孵出を始める。

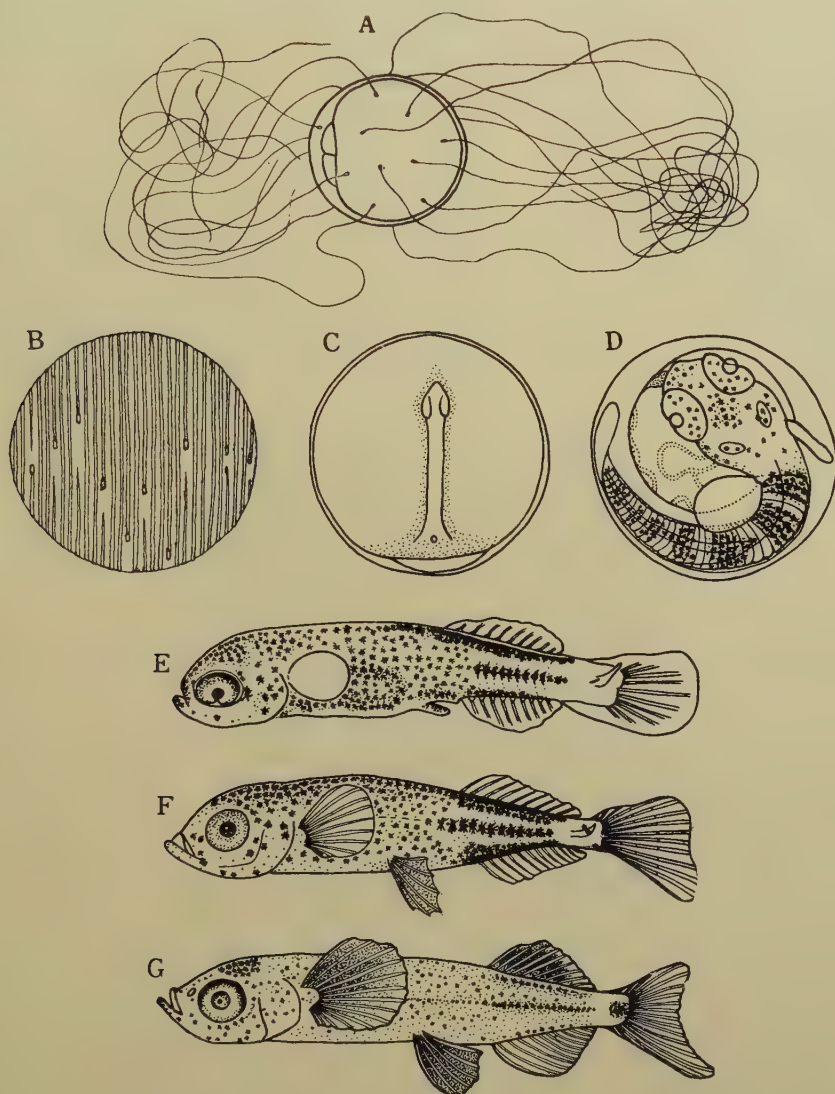


Fig. 3. Eggs and developmental stages.

A. Egg with adhesive tendrils, B. Ripe ovarian egg, C. 1.5 days-embryo, D. 7 days-embryo, E. Newly hatched larva, 5 mm in total length, F. Post-larva, 7 mm in total length, G. Juvenile, 15 mm in total length.

4. 発 育

前期仔魚 (Fig. 3 E)：孵化直後の仔魚は、全長 4.5~5.2 mm で、卵黄を僅かに持つてはいるが、体制はかなり進んでおり、口はよく発達してやや斜め上方を向き、垂直鰭は既に夫々分化し、腹鰭と共に鰭条も形成されているが、胸鰭のみは膜鰭状である。生時には、眼

は黒紫色、体色は背部が黒褐色、腹部は銀白色をおびた淡黄褐色、腹鰭は緑黒色で、背鰭基部、臀鰭基部及びこれに狭まれた体側中央部に顕著な黒色帯が認められる。孵化直後の仔魚で、頭部が銀白色で体の前部が淡黄色、体の後半部が黒みをおびたものも見られたが、この種のもは孵化後数日で殆んど死亡した。孵化した仔魚は、直ちに頭部をやや斜めに水面に向け、尾部を左右に細かく動かして、表層及び中層を活潑に泳ぎ廻り、孵化後間もなく、Brine shrimp の幼生を盛んに摂餌する。

後期仔魚 (Fig. 3 F): 孵化後5日で全長 7.0~7.1 mm に達し、頭部及び体側下方は銀白色をおび、背部は淡黄褐色の地色に黒色色素胞が散在し、体側中央部の黒色帯が顕著で、尾柄部は乳白色をなすが、脊椎骨末端に数個の黒色胞が認められる。腹鰭は赤褐色で、各鰭の鰭条はほぼ定数に達する。この頃になると胸鰭をはり、表層を活潑に游泳し、僅かながら水面を滑走する習性が現われ始める。

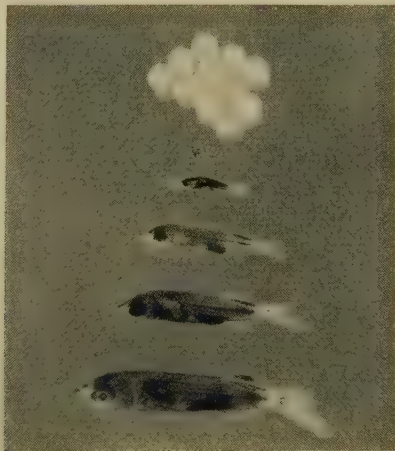


Fig. 4. Eggs, larvae and juveniles. $\times 2$

稚魚 (Fig. 3 G, 5): 天然に採集した全長 15 mm の稚魚では、胸鰭はまだ丸みをおびているが、背鰭の前部鰭条がやや延び始め、背鰭前部の鰭膜に黒色色素胞が生ずる。この程度の大きさのものは潮目に多く見られ、多少の群をなしており、たも網で採集することが出来る。全長 25 mm のものでは、ほぼ成魚と同様の形態を示し、背鰭が著しく高くなり、胸鰭は伸長し、尾鰭は無色であるが、その他の鰭は何れも黄色の輝いた地色に赤褐色及び黒色の色素胞が散在する。体も美しい黄金色で、体側後部には赤褐色の色素胞が散在する (Fig. 5)。この程度の稚魚になると、集魚灯下に現われ始め、或程度の距離を飛翔する。本種と形態が類似し、天草沖で同時に出現する近縁のツマリトビウオ *Parexocoetus brachypterus brachypterus* の稚魚 (Fig. 6) は、下顎に1対のひげを生ずるが、本種の稚魚にはひげを生じない。しかし下顎の先端に短かい突起を生じ、口の形態がサンマ *Cololabis saira* (Brevoort) に類似した形状を示す (Fig. 7, 8)。この突起はトンガリトビウオ属 *Fodiator* の幼期の下顎に見られるような、サヨリ型の長いものではないが、これと相同のもので、ツマリトビウオ属 *Parexocoetus* のうち本種はトンガリトビウオ属 *Fodiator* に極めて近縁のものと考えられる。

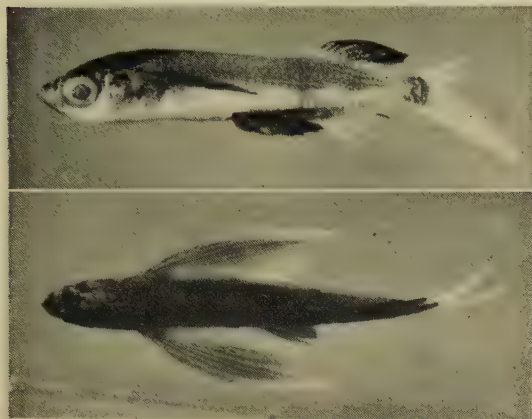


Fig. 5. Lateral and dorsal views of juvenile. $\times 2$

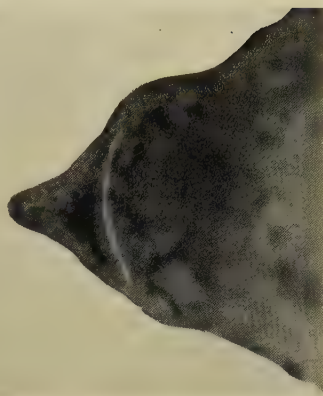


Fig. 8. Dorsal view of lower jaw.



Fig. 6. Juvenile of *Parexocoetus brachypterus brachypterus* with the barbel of lower jaw. $\times 1$



Fig. 7. Prolonged lower jaw from specimen 25 mm in total length.

5. 成長と年令

本種は回游魚で当水域のみでは周年に亘る資料の採集が出来ないこと、多数の標本の採集が困難なこと、産卵期が比較的長くて天草に出現する稚魚・未成魚の体長組成に大きな変異の幅が生ずること等のため、天然採集の資料から成長度を明らかにすることは容易でない。1955年の採集個体の fork 長組成を月別に整理し、これに人工受精して孵化飼育したものを加えて、Fig. 9 に示した。稚魚及び未成魚には、当水域での発生群と、暖流によって運ばれて来た南方海域での発生群と思われるものとが混在して、fork 長組成に相当の幅を生じている。――

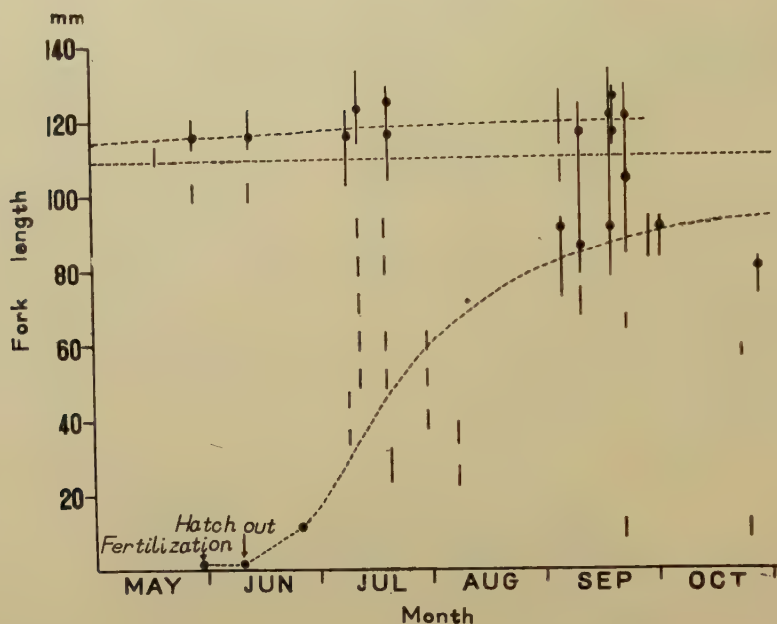


Fig. 9. Length-time distribution of larvae, juveniles and adults taken from Amakusa Islands.

— range of fork length, ● mode, ... growth curve.



Fig. 10. Scale with one annuli from specimen 12 cm in fork length. $\times 12$

産卵盛期の6・7月に発生したものは、その秋には fork 長 80~90 mm, 満1年で 120 mm 程度に成長するもので、その成長は比較的早い。この海域で 5~10月 に採集される fork

長 100 mm 以上のものは、前年度に発生し産卵に来游したもので、検鱗の結果とも一致する。鱗は円鱗で、露出部の circuli の間隔は被覆部のそれより狭いが、ともにその粗密は認められない (Fig. 10)。検鱗に用いた鱗は、体側の胸鰭下部の最も大形のもの 10 枚で、これを投影拡大して観察した。成熟した個体の鱗には、その縁辺近くに顕著な circuli の乱

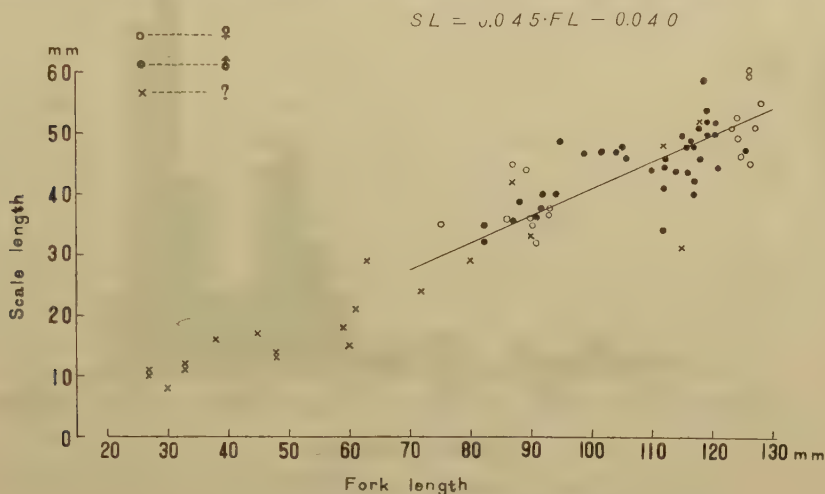


Fig. 11. Relationship between the fork length and scale length.
 SL : scale length, FL : fork length.

Table 2. Relation between forklenght and annual ring.

Range of fork length (mm)	Annual ring class	
	0	1
25 — 80	18	
81 — 85	3	
86 — 90	10	
91 — 95	5	
96 — 100	3	
101 — 105	1	1
106 — 110		6
111 — 115		12
116 — 120		12
121 — 125		9
Total	40	40

れを生じており、その外側の鱗相は極めて薄くなっている。これは營養成長より生殖成長に移る体の生理条件の転換により生ずるものと思われ、この circuli の乱れを年輪とした。本種のような適水温を求めての移動が顕著なものは、冬期も順調に成育するものであろう。fork 長と鱗長との関係は直線的で、Fig. 11 に示した fork 長 25~125 mm のもの 80 個体について、輪数を調べた結果は Tab. 2 に示したが、2 輪以上のものは全く認めら

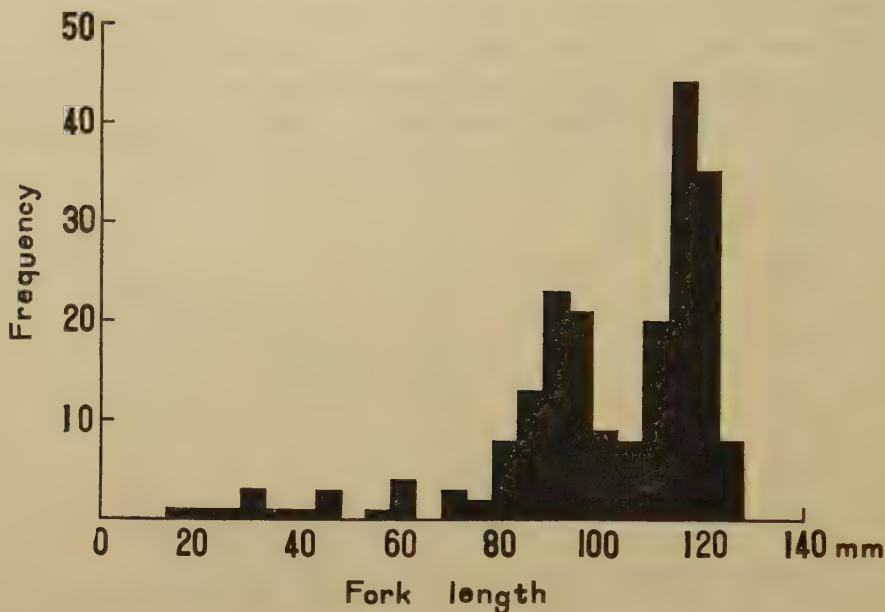


Fig. 12. Fork length-frequency distribution sampled during 1955.

れなかつた。

この結果 fork 長 105 mm 以上のものに 1 輪が認められる。この輪形成時期は冬期 2～3 月頃で、計算 fork 長 109.2 mm で 1 輪形成される。1955 年に採集し得た全個体の fork 長組成を Fig. 12 に示したが、fork 長 90 mm と 120 mm との 2 つのモードを異にするものが認められるが、前者は 1955 年の発生群で、後者は前年の発生群である。

産卵後及び冬期の成魚の採集資料がなく、断定を下すことは困難ではあるが、体長組成及び大形ものでも年輪が 1 輪しか認められないことより、その寿命は満 1 年余で、産卵後の親魚は斃死するのであろう。

6. 摘 要

(1) バショウトビウオは小形の単葉のトビウオで、天草西海岸に成魚は 5 月中旬～9 月下旬、仔稚魚及び未成魚は 7 月上旬～10 月下旬に出現する。

(2) 稚魚より成魚に至るまで、夜間集魚灯下に集まる習性があり、主として小形の甲殻類を食餌とする。

(3) 産卵期は 5～9 月、その盛期は 6～7 月で、卵は球形纏絡卵で、卵径 1.7mm、卵膜に約 20 本の纏絡糸を有する。1 尾の抱卵数は 1,000～2,000 個である。

(4) 水温 21～25°C で受精後約 10 日で孵化し、孵出は夜間行われる。孵化直後の仔魚は全長約 5 mm で、活潑に表層を泳ぐ。

(5) ツマリトビウオ属 *Parexocoetus* の幼期には、下顎にひげを生ずるとされているが、本種の幼魚にはひげを生じない。しかし幼期のみ下顎がサンマ型に突出する。

(6) 6～7月に産まれた稚魚は、その秋には fork 長 80～90 mm, 満1年で 110～120 mm 程度に成長し、満1年で産卵する。

(7) 成熟した個体の鱗には、冬期形成された年輪が1輪認められるのみで、産卵した親魚は斃死するのであろう。

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R é s u m é

Parexocoetus mento (Cuvier et Valenciennes) is a small-sized, two-winged flying fish found in the southern waters of Japan; fig. 1 shows the adult. The writers studied its life history and habits on the western coast of Amakusa Islands in Kyushu. The specimens were collected during the period from May to October, 1955. The results obtained are summarized as follows:

(1) The adult appeared in this region from the middle of May to the late September, and the larvae, juvenile and half-grown fish were found from early June to late October.

(2) They were attracted to a flood light at night, with the pectoral and ventral fins spread out, and swam sluggishly about near the light, so that they were very easily captured by a dip net. They feed entirely on planktonic organisms, mostly copepods. A great many stomachs have been examined and nothing ever was taken out of them but a pinkish paste of organisms containing many crustacean fragments.

(3) The spawning season is from May to September and the peak is in June and July, and the spawning act takes place soon after the sunset and lasts till the next morning. The number of eggs carried by an adult female varied from about 1,000 to 2,000. The egg is spherical, 1.75–1.78 mm in diameters, with about 20 long tendrils distributed over the whole surface. The yolk is

transparent and the oil-globule is absent (Fig. 2, 3A).

(4) The eggs were stripped and inseminated with milt from the male. The embryonic development was observed and the hatched larvae were reared in the aquarium, fed with the nauplii of brine shrimp. It takes about 10 days at 21°-25°C. water temperature to hatch out, and most larvae hatched out in several hours after sunset. The newly hatched larvae were about 5 mm in total length (Fig. 3E).

(5) The newly hatched larvae swam close to the water surface and darted about actively in the aquarium, and fed actively on the nauplii of brine shrimp. In the larval stage, the body is a little more robust. The fin rays have definitely developed except the pectoral fins. The color of body is dark brownish above and bright yellow brownish below. The ventral fins are dark greenish.

(6) In the juvenile stage, the dorsal fin becomes elevated and is wholly black except the basal part. The ventral fins are large and almost brownish. The characteristic three rows of melanophores situated along the dorsal and anal bases and in the lateral portion of posterior body are observed. The barbel of the lower jaw is absent, but the lower jaw is a little produced as in the sauries, *Scombresocidae* (Fig. 7, 8). These small fishes occasionally made short, sporadic flights and surface skips.

(7) In the specimens longer than 25 mm in fork length, the shape of body agrees with the adult form and the color is dark bluish above and silvery white below. They show a tendency to leave this region for the southern waters in winter.

(8) For the growth and age-determination, we used the scale characters and the plotting frequency distributions of body size (Fig. 9). In this discussion the scale of adult shows one ring, "cutting-over" (Fig. 10). It is considered that the ring begins to form in February or March and the formation seems to be due to the metabolic change brought about by the production of sexual elements. Sexual maturity is attained at the end of their first year, when the males have reached a size of about 98 mm and the females about 110 mm in fork length. The largest size is about 123 mm in male, about 130 mm in female in fork length. Most fish seems to die after the first spawning. The ratio of males to females was 5 in adult.

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天草におけるトビウオ類の研究

第3報 *Cypselurus* 属3種の生態・生活史

塚原 博・塩川 司・稻尾 正

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The life histories and habits of three species
of the genus *Cypselurus*

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天草におけるトビウオ類の研究¹⁾

第3報 *Cypselurus* 属3種の生態・生活史 (1)²⁾

塚原 博・塩川 司・稲尾 正

Studies on the flying-fishes of the Amakusa Islands. Part 3. The life histories and habits of three species of the genus *Cypselurus* (1)

Hiroshi Tsukahara, Tsukasa Shiokawa and Tadashi Inao

天草西海岸に出現するトビウオ類について、1955年までの調査で、成魚は5種、稚魚及び未成魚を含めば13種を認めたが、このうち漁業上重要なものは、ハマトビウオ属 *Cypselurus* のホソトビ・アリアケトビウオ・ツクシトビウオの3種である。この3種のトビウオは、毎年5月はじめに南方より天草沿岸に姿を見せ、西海岸において5月上旬より7月上旬にかけて、アゴ網漁業の漁獲の対象となつている。これら3種のトビウオについては、阿部宗明(1953, '54)が分類上の記載をし、村上守郎・真道重明(1948)がわれわれと同じ天草・富岡産の大部分ホソトビと思われる材料で、トビウオ *Prognichthys agoo* として、体長及び体重組成・肥満度・生殖巣重量・雌雄比等について計測結果を報告している。また川村久明(1953, '56)は福岡・志賀島の大敷網に入るこれら3種(ツクシトビウオについてはトビウオとしている)について、体長分布・産卵期・生殖巣重量指数・肥満度・年令・食性・気象及び海況と漁況等を報告し、上野雅正・中原官太郎(1955)が同じく志賀島産のもので、アリアケトビウオの人工授精と仔魚を飼育した結果を発表している。今井貞彦(1955)は薩南海域で採集されたこれら3種の稚魚の形態及び生態について記載している。

筆者等は天草西海岸で自ら採取した材料を用いて、ツクシトビウオ・ホソトビの生態・生活史を明らかにするとともに、アリアケトビウオについては上記の上野・中原の記載と稚魚の形態について相当の差異を認めたので、ここに3種の生態・生活史について比較報告する。この研究は、塚原が計画・取纏めを主として行い、塩川は生態の観察、稲尾は卵内発生・仔魚飼育の観察を分担し、現場での採集・観察は共同で行つた。この報告について、御指導及び本稿の御校閲を頂いた内田恵太郎・相川広秋両教授、夜間現場での採集調査に助力を惜まれなかつた天草臨海実験所の所員の方々に厚く御礼申しあげる。

1. 材料及び方法

この研究はすべて九州大学理学部附属天草臨海実験所において行い、天草・富岡のえびす崎沖を主とした天草西海岸の距岸約4哩の漁場で、トビウオ流刺網を使用して自ら漁獲

1) 九州大学農学部水産学教室業績及び九州大学理学部附属天草臨海実験所業績 No. 97.

2) 日本水産学会秋期大会(長崎, 1955年10月)にて発表。

したものを用いた。使用した漁具は、高さ 2.25 m、長さ 50 m の一重の浮刺網で、上層 1.5 m は絹網 50 目、下層は綿網 20 目の 8 節で出来ており、この網を 5 網連結して採集を行つた。操業は実験所の 1 屯・6 馬力の和船型の採集船はやさき丸を使用し、われわれが所員 2、3 名とともに夕暮時に投網して適時網揚げを行い、終夜漁獲調査を行いつつその生態を観察し、夜明けに調査を終えて帰港し、資料の測定整理を行つた。人工授精には、漁獲直後船上において生殖巣の完熟した成魚を選別して用い、受精卵は実験室内の流水の水槽に移して卵内発生を観察し、孵化後の仔・稚魚は止水にした水槽で飼育し、水槽の外側に海水を流して水槽内の水温をなるべく自然環境の水温に近からしめた。仔・稚魚の餌料には Brine shrimp の乾燥卵よりえた nauplius を与えた。また天然の稚魚採集には、水産調査艇おしま丸 (7.1 屯・25 馬力) の 3 キロワットの集魚灯を用い、夜間灯下に集まる稚魚をたも網で採集し、稚魚網による採集も行つた。

2. 成 魚 の 形 態

ツクシトビウオ *Cypselurus heterurus döderleini* Abe 方言 (天草) カクアゴ

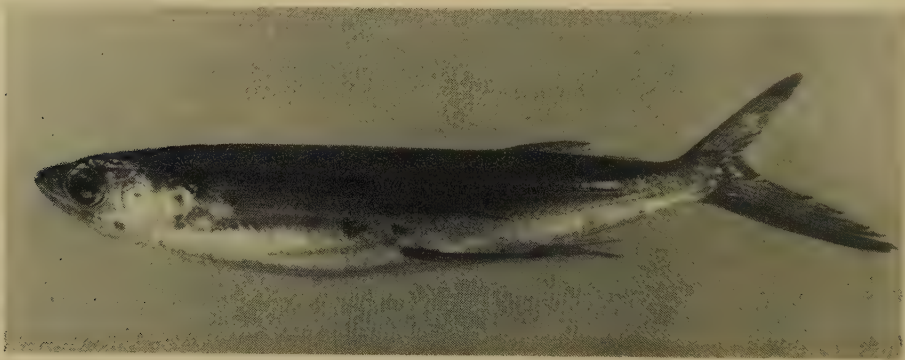


Fig. 1. Adult of *Cypselurus heterurus döderleini* Abe.
Fork length 28 cm.

本種は成魚の全長 27~34 cm の 3 種中最も大形のトビウオで、体はやや細長く、腹部前方がやや角張っておりカクアゴの名がある。腹鰭は中位で、吻端から腹部起部までの距離は体長のはぼ 60 %、背鰭 13~14 軟条、臀鰭 6 軟条で、脊椎骨数は 47~49 で 3 種中最も多い。胸鰭はその中央部を除き淡い暗紫色で、その先端より後縁部及び下部は透明である。天草沿岸には最も早く出現し、その分布は屋久島以北の日本沿岸のほとんど各地に見られ、北は北海道石狩湾まで達すると云う。幼期には 1 対の美しい黄色のひげを有する。

ホソトビ *Cypselurus opisthopus hiraii* Abe. 方言 (天草) マルアゴ

3 種のうち中形のトビウオで、全長 23~28 cm 程度になり、体は細長く、腹鰭は後位で吻端から腹鰭までの距離は体長の 60 % 以上、背鰭 13~14 軟条、臀鰭 6 軟条で、脊椎骨数は 45~46。胸鰭は淡い暗紫色で、先端及び下方は無色透明である。九州西・北海岸で最も多

Table 1. Counts and measurements of *Cypselurus heterurus döderleini*.

No. of fish	1	2	3	4	5	6	7	8	9	10
Total length (mm)	295	302	303	312	314	315	315	316	318	322
Fork length	246	249	253	260	258	255	258	262	261	264
Standard length	232	232	236	246	242	243	243	245	244	248
Body weight (g)	176	171	165	193	190	208	195	183	183	194
Sex	♂	♂	♂	♂	♀	♀	♀	♂	♂	♂
Gonad weight	5.2	5.3	7.0	7.4	8.1	11.0	8.0	4.3	2.7	4.1
Number of vertebrae	47	47	48	48	47	49	48	47	48	48
Dorsal rays	13	13	13	14	13	14	13	13	13	13
Anal rays	6	6	6	6	6	6	6	6	6	6
Pectoral rays	13	15	15	15	16	15	15	15	14	14
Predorsal scales	33	33	35	33	33	33	33	36	33	34
Gill-rakers	6+17	6+16	6+16	7+18	7+15	6+16	7+17	6+17	7+18	8+18
Depth	42	42	40	43	43	51	41	42	43	42
Width	31	28	28	31	31	33	31	30	30	30
Predorsal length	163	163	166	174	173	174	176	172	173	177
Preventral length	135	136	140	138	138	140	143	140	137	142
Preal length	185	184	181	198	191	196	198	192	193	198
Head length	52	50	52	49	51	51	53	52	54	56
Snout length	13	12	12	13	11	15	13	12	12	13
Eye length	20	18	20	19	18	18	18	21	21	20
Interorbital width	17	17	18	17	18	18	17	18	16	18
Pectoral-fin length	164	166	156	161	160	166	165	165	168	167
Ventral-fin length	77	79	73	75	79	82	81	77	78	78
Dorsal-fin length	25	24	24	23	27	28	25	25	22	23

(Date of collecting : June 11, 1955)

いトビウオで、北海道西南部以南の本邦のほとんど各地の沿岸に見られると云う。幼期には1個の黒色の花弁状のひげを有する。

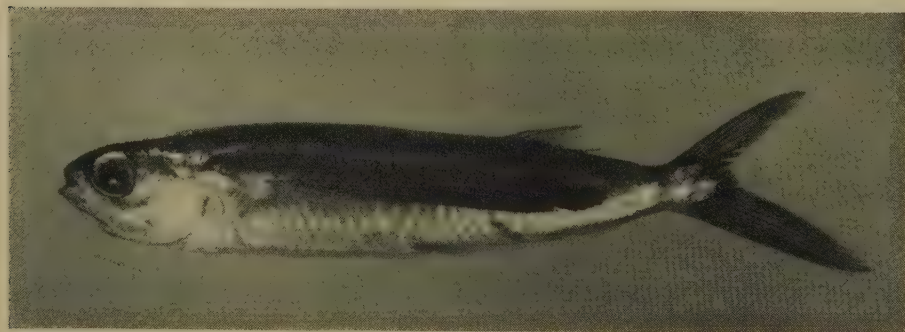


Fig. 2. Adult of *Cypselurus opisthopus hiraii* Abe.
Fork length 22 cm.

Table 2. Counts and measurements of *Cypselurus opisthopus hiraii*.

No. of fish	1	2	3	4	5	6	7	8	9	10
Total length (mm)	247	249	254	255	256	256	258	260	262	266
Fork length	211	212	214	216	214	217	210	220	220	220
Standard length	198	198	200	201	200	203	198	206	208	208
Body weight (g)	115	124	100	114	106	116	116	117	145	140
Sex	♀	♀	♂	♂	♂	♂	♀	♂	♀	♀
Gonad weight	11.1	14.8	4.9	6.4	6.4	4.6	16.2	8.4	26.2	22.0
Number of vertebrae	45	46	46	45	46	45	46	46	46	46
Dorsal rays	14	13	13	13	13	13	14	13	13	13
Anal rays	6	6	6	6	6	6	6	6	6	6
Pectoral rays	15	15	15	15	15	15	15	15	15	15
Predorsal Scales	34	34	33	34	34	32	33	34	35	34
Gill-rakers	6+20	6+21	6+20	7+21	7+21	7+22	7+22	7+22	6+19	7+22
Depth	36	41	33	37	36	38	41	36	44	41
Width	26	38	26	29	29	29	31	30	31	34
Predorsal length	144	140	141	140	140	142	140	146	146	146
Preventral length	122	119	120	120	124	121	118	124	125	125
Preanal length	160	160	160	162	160	162	157	166	169	166
Head length	42	41	42	43	42	44	45	45	45	45
Snout length	10	10	11	11	11	11	11	10	11	10
Eye length	13	15	13	13	14	15	14	13	13	13
Interorbital width	13	15	13	14	14	15	14	14	13	13
Pectoral-fin length	121	120	123	126	127	129	126	122	126	134
Ventral-fin length	57	55	56	56	56	56	58	55	57	58
Dorsal-fin length	20	22	20	23	24	22	23	22	21	20

(Date of collecting : June 11, 1955)

アリアケトビウオ *Cypselurus starksi* Abe 方言 (天草) チョウセンアゴFig. 3. Adult of *Cypselurus starksi* Abe. Fork length 20 cm.

3種のうち最も小形のトビウオで、全長 22~27 cm 程度で、体は比較的太短く、腹鰭は前位で吻端から腹鰭までの距離は体長の 60 % 以下、背鰭 12~14 軟条、臀鰭 6 軟条で、脊椎骨数は3種中最も少くて 43~44。胸鰭は下方及び先端の小部分を除いては青黒色を呈する。天草沿岸には3種中最も遅く出現し、本州中部以南に分布すると云う、幼期にもひげを生じない。

Table 3. Counts and measurements of *Cypselurus starksi*.

No. of fish	1	2	3	4	5	6	7	8	9	10
Total length (mm)	224	231	232	234	250	251	252	254	254	266
Fork length	184	194	196	197	206	209	207	211	214	228
Standard length	170	176	180	180	190	191	190	198	196	200
Body weight (g)	92	102	97	95	114	125	120	117	145	145
Sex	♂	♂	♂	♂	♂	♀	♀	♀	♀	♀
Gonad weight	1.2	1.4	1.1	0.8	1.6	12.8	23.4	7.2	15.5	29.9
Number of vertebrae	43	43	44	43	44	43	44	44	44	44
Dorsal rays	13	13	13	12	14	12	13	13	13	13
Anal rays	6	6	6	6	6	6	6	6	6	6
Pectoral rays	16	17	15	15	15	16	16	15	15	16
Predorsal scales	30	31	30	30	32	30	33	30	31	30
Gill-rakers	7+16	5+16	5+17	7+16	7+17	6+17	6+17	7+18	6+14	6+17
Depth	37	37	35	35	38	41	40	43	44	45
Width	27	28	26	27	29	31	32	33	33	35
Predorsal length	122	122	123	123	131	136	134	138	141	144
Preventral length	100	100	100	105	110	109	111	114	112	118
Preanal length	139	141	142	144	153	153	154	157	158	165
Head length	41	39	41	41	45	42	43	43	43	44
Snout length	9	9	10	10	10	10	11	10	10	10
Eye length	15	12	12	14	15	15	12	14	15	14
Interorbital width	15	15	14	16	15	16	15	15	16	15
Pectoral-fin length	113	118	113	117	122	124	122	120	126	126
Ventral-fin length	51	53	55	55	52	59	55	56	58	57
Dorsal-fin length	18	21	22	20	23	22	21	18	21	22

(Date of collecting : July 11~20, 1955)

3. 生 態

海況、気象及び月令と漁獲との関係及び産卵生態を調べることを目的としたが、いろいろの困難のため調査回数も少くなり、十分な目的を果すことが出来なかつた。調査は夕刻に出かけ、天候・水温・比重等を観測した上で、日没直前に潮流の方向に対してほぼ直角に一直線に網入れを行い、潮流に流されながら、一定時間間隔で網を見廻つて、刺さつたトビウオについて種類・性別・羅網位置を記録しつつ採取した。網にかかる魚はほとんどトビウオで、時にハマダツがかかり、稀にトカゲエソがかかるが極めて少い。1955年5月9日より9月26日までの間、11回調査を行い、その漁獲の結果を Table 4 に示した。

Table 4. Numbers of three species caught with our gill nets.

Date		May					June		July		Aug.	Sept.	Total
		9	14	16	23	27	4	12	9	20	3	26	
Water temp.		19.0	20.4	20.0	20.1	20.5	21.0	22.2	23.5	26.3	27.5	24.0	
Age of the moon		16.6	21.6	23.6	1.3	5.3	13.3	21.3	19.0	0.6	14.6	9.9	
<i>C. opisthopus hiraii</i>	♀	2	4	4	6	4	19	84	14	9	1	0	145
	♂	49	90	60	63	19	119	522	44	18	3	0	989
	total	51	94	64	69	23	138	606	58	27	4	0	1134
<i>C. heterurus döderleini</i>	♀	1	1	0	1	1	2	3	0	1	0	0	10
	♂	0	4	0	1	6	2	2	2	3	0	0	20
	total	1	5	0	2	7	4	5	2	4	0	0	30
<i>C. starksi</i>	♀	0	0	0	0	0	0	3	2	8	2	0	15
	♂	0	0	0	0	0	1	3	8	32	15	3	62
	total	0	0	0	0	0	1	6	10	40	17	3	77
Total		52	99	64	71	30	143	617	70	71	21	3	1241

3種の漁獲比率の推移は、われわれの操業結果では5月上旬より7月上旬にかけてホソトビが極めて多く、これにツクシトビウオが僅かに漁獲されるが、6月はじめよりアリアケトビウオの来游が見られ、7月上旬にはホソトビの減少に代つてアリアケトビウオの漁獲が多くなるが、その全量は急激に減少する。又雌雄は、ホソトビについて漁期の進むにつれて雌魚の割合が幾分かは増加するが、全漁期を通じて常に雄魚が極めて多く、他の2種についても雄魚が雌魚に比して多い。

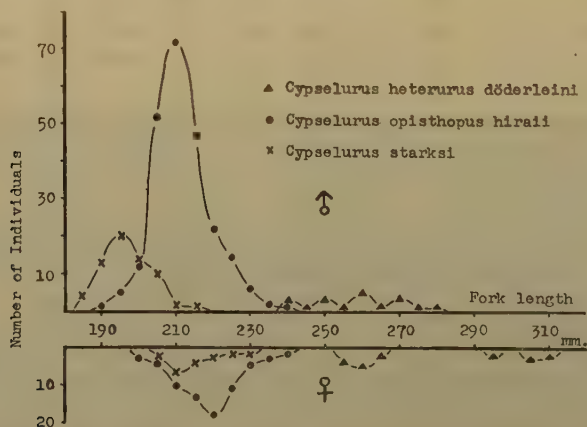


Fig. 4. Fork length distribution of three species of the genus *Cypselurus* which were caught with our gill nets.

この調査で漁獲された3種の Fork 長について、ホソトビは毎回 30 尾、他の2種は全部を測定した結果を Fig. 4 に示した。ツクシトビウオが最も大形で、ホソトビ、アリアケトビウオの順に小形になり、何れも雌魚が雄魚に較べて大きい。

最も漁獲の多かったホソトビについて、その活動及び游泳層の時間的変化を知るために、網に刺さったトビウオの漁獲水深をすべて記録し、その結果を午後7時より翌朝の午前5時までの羅網時間と水深を集計して、Fig. 5 に千分率で示した。この結果から、網に刺さ

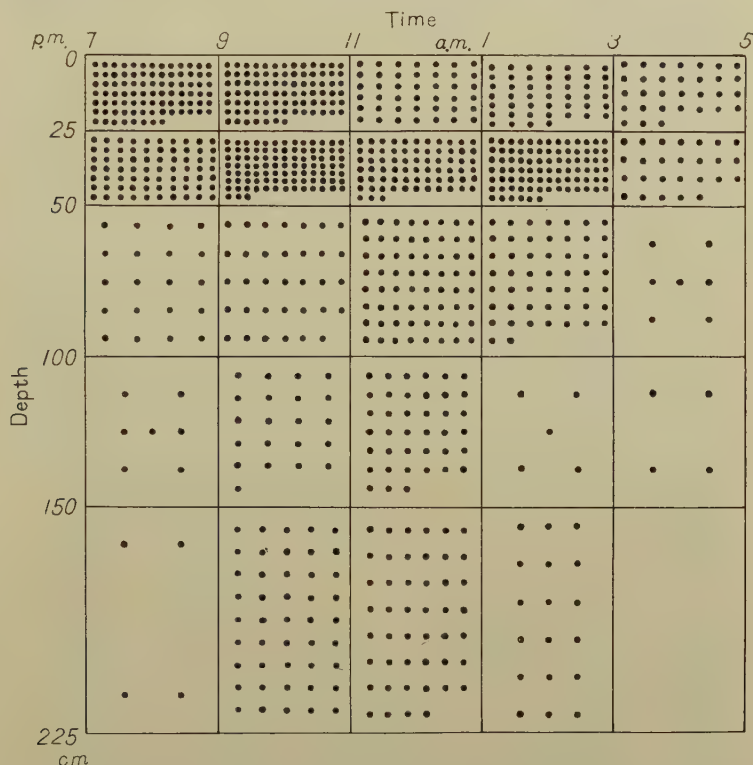


Fig. 5. Changes in the abundance of *Cypselurus opisthopus hiraii* in the vertical distribution throughout the night. The dots indicate as the ratio of one per thousand.

る率を活動の度合と考えれば、日没とともに活潑な活動が始まり、午後9～11時にその動きが最も盛んで、これより漸次減少し、午前3時を過ぎると急にその動きが落ちる。又日出直前には多少の動きが見られる。概して日出前よりは日没後の方が活動が盛んで、この動きの変化は産卵のため沿岸に寄せる行動とも密接な関係があると思われる。

又夜間の游泳層は表面から1mの範囲に極めて多いが、そのうちでも26～50cm層が最も多く、0～25cm層、51～100cm層がこれに次いでいる。日没直後には極めて表層を游泳しており、0～25cm層が最も多く、26～50cm層がこれに次いでいるが、時間が経つとともに游泳層がが下層に拡がり、26～50cm層と0～25cm層との順位が逆転し、

これより下層にも多くなる。この傾向は午前3時頃まで続くが、夜明けに近づくとともに魚群が浮上して、日没直後とほぼ同じ傾向に戻る。

又游泳方向と潮流の方向との関係については、潮流の方向に網にささるものが65%、潮流に逆つてささるものが35%で、潮流にそつて游泳するものが多い。又対象が産卵群であるので、夜間沿岸に来游して産卵し、夜明とともに沖合に去るのではないかと考えて、この移動の時間的变化を調べたが、はつきりした結果は得られなかつた。

4. 卵及び卵内発生

卵は何れも沈性纏絡卵で球形をなし、囲卵腔はやや狭く、卵膜は無色透明で、その表面には長い纏絡糸を有する。卵径はツクシトビウオが1.86 mm (1.77~1.9 mm) で最も大きく、アリアケトビウオが1.66 mm (1.6~1.7 mm) でこれに次ぎ、ホソトビが1.47 mm (1.44~1.5 mm) で最も小さい、卵黄は何れも極めて淡い黄色を有するが、そのうちではツクシトビウオの卵がやや濃色で、アリアケトビウオがこれに次ぎ、ホソトビの卵は最も淡くて、ほとんど無色透明に近い。纏絡糸は何れも約50本で、その長さは10 mm 内外で顕著な差異は認められないが、ツクシトビウオが他に比してやや太めで堅く、アリアケトビウオは最も柔軟である。

漁期の始めには生殖巣の成熟途上の個体が認められるが、盛期には雌雄とも成熟、完熟個体が多く、漁期の終りには放卵、放精の個体が多くなる。3種とも15 g 以上の成熟した卵

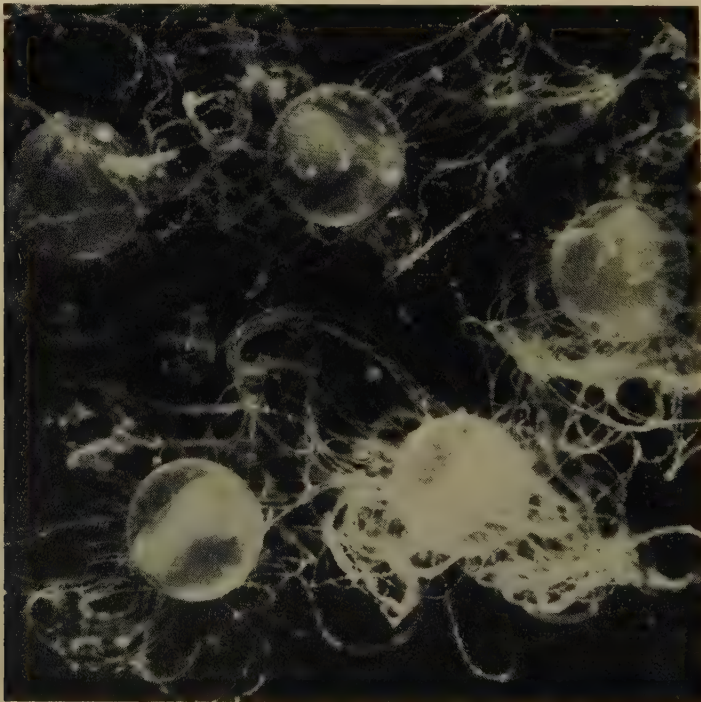


Fig. 6. Eggs of *Cypselurus heterurus döderleini*. $\times$ ca. 10

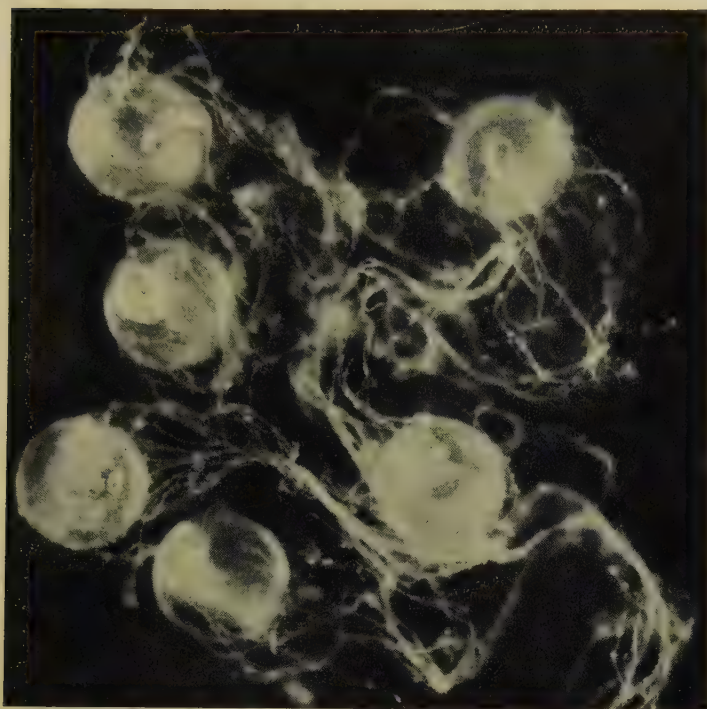


Fig. 7. Eggs of *Cypselurus opisthopus hiraii*. $\times$ ca. 11

巢では、卵径が 1.5 mm 以上の卵群と 0.6 mm 以下の小さい卵群とに分離することが出来、小さい卵群はその年には産卵されないものと思われるで、孕卵数として卵径 1.5 mm 以上のものを計測した。3 種とも卵巣重量 15 g 以上のもの 10 個体を調べ、ツクシトビウオの孕卵数は Fork 長 258~268 mm のもので平均 9,580 (8,670~10,130), ホソトビは Fork 長 212~226 mm のもので平均 5,890 (3,960~7,650), アリアケトビウオは Fork 長 208~228 mm のもので平均 5,300 (3,600~8,117) の結果を得た。

3 種のトビウオの産卵期は、漁獲の対象となつているものが産卵群であるため、この地方の漁期とほぼ一致し、ツクシトビウオ・ホソトビは 5~7 月、アリアケトビウオは 7~8 月で、産卵時の表面水温は前者が 20~25°C、後者は 25~28°C である。

人工授精はツクシトビウオ・ホソトビについては 1955 年 5 月 14 日午後 10 時 20 分に、アリアケトビウオは同年 8 月 4 日午後 10 時 15 分に、何れも調査船上で乾導法によつて行い、卵は実験室に持ち帰つて飼育観察した。ツクシトビウオ・ホソトビの卵飼育時の水温は 20~22°C、アリアケトビウオは 26~28°C であつた。卵内発生の経過は、3 種とも一般の硬骨魚卵のものと比較して特別な差異は認められない (Figs. 13, 14, 15 の B, C, D)。ツクシトビウオの卵では、胚体に色素胞の出現する頃になると、赤褐色胞により卵全体の外観が褐色を呈するものと、黄色胞のみで黄色に見えるものと 2 つの系統が現われるが、この区別は孵化後仔魚期にも当分認められる。ホソトビ・アリアケトビウオでも胚体の色調の変異は多少認められるが、ツクシトビウオほど顕著ではない、ホソトビの卵は概して淡黄色

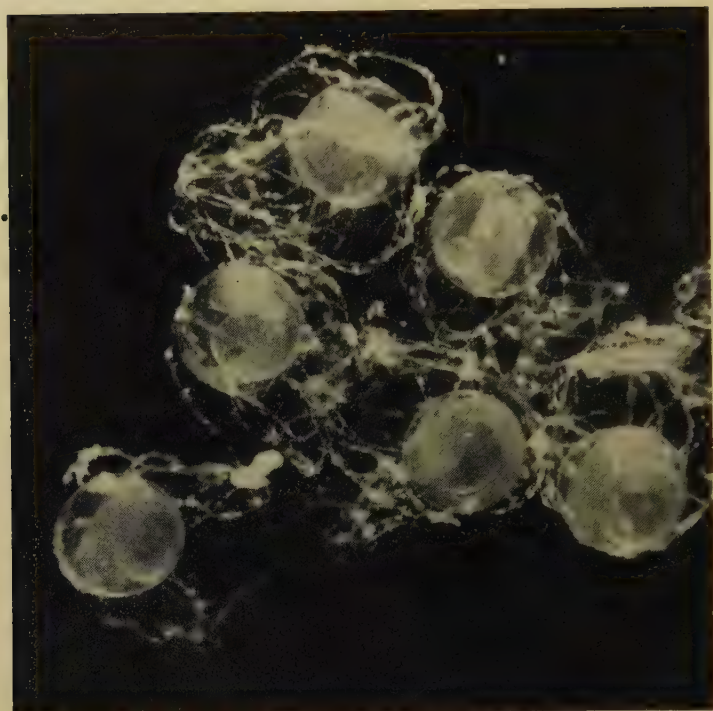


Fig. 8. Eggs of *Cypselurus starksi*. $\times$ ca. 10

を呈し、アリアケトビウオの卵は赤褐色を呈し卵黄の表面全体に濃橙色の血管が覆う。孵化までに要した時間は、ツクシトビウオ・ホソトビは水温 $20\sim 22^{\circ}\text{C}$ で約 2 週間、アリアケトビウオは水温 $26\sim 28^{\circ}\text{C}$ で 5～7 日であつた。孵出は何れも日没後の数時間位の間に限られ、この時間以外に孵出することがほとんどない。この時間まで灯下に置いた場合には孵出しないで、暗くして暫くすると孵出を始め、孵出には光と密接な関係がある。孵出は尾部から極めて迅速に行い、孵出が始まつて全部の卵が孵化を完了するのにツクシトビウオ・ホソトビは 4 日、アリアケトビウオでは 2 日を要した。

5. 仔 魚 期

a) 前期仔魚

ツクシトビウオ： 全長 6.3 mm (Fig. 13 E) 孵化直後のもので、卵黄はなお認められるが体制はかなり進み、口は既によく発達し、眼は青白色、体色は赤褐色のものと黄色のものと 2 系統がある。鰭は仔魚膜鰭状で透明、軟条の原基は僅かに認められ、尾鰭の後縁は丸く、軟条にそつて点々と黒色胞が見られ、黄色の鰭が顕著に見られるものと不明瞭なものがある。孵化後直ちに体をやや斜め上方に向けて尾部を激しく左右にふつて活潑に表層を遊び廻る。孵化後半日で群をなす習性が現われ始め、胸鰭を掀げてやや安定した遊び方を示す。孵化後 1, 2 日すると海藻につく習性を示し、殊に水槽に振動を与えるとすばやく海藻に姿を隠し、静まると姿を現わし海藻の周辺を遊び廻る (Fig. 9)。この時期まで卵黄は多少残っているが、Brine shrimp の幼生を与えると盛んに摂餌する。

ホソトビ： 全長 4.7 mm (Fig. 14 E) 形態はほぼツクシトビウオに類似するが、体がやや短かく、黄色の鰭が顕著に認められ、体色は淡い黄・橙・鼠・黒色と色調に種々の変異が見られるが、概して淡い色調で、尾緒を除いて各緒の軟条の原基がまだ認められない。孵化後半日すると大部分体色は黒みを増す。習性はツクシトビウオと全く同様である。



Fig. 9. Larvae attached to the sea-weed in aquarium. $\times$ ca. 1.2

アリアケトビウオ： 全長 4.4 mm (Fig. 15 E) 孵化直後は ツクシトビウオの 褐色系の仔魚と酷似し、体色は赤褐色で、眼も赤褐色を呈し、垂直緒の軟条の原基もやや明瞭に認められる。孵化後半日で体は一面に黒褐色となる。游泳はツクシトビウオ・ホソトビに比して不活潑で、表層に浮泛して静止していることが多いが、お互に胸緒や尾緒に食いつく動作が見られる。

b) 後期仔魚

ツクシトビウオ： 全長 7.0 mm (孵化後 3 日, Fig. 13 F) 卵黄は吸収され、垂直緒は各々分化し、軟条原基もほぼ定数に達し、胸緒・腹緒は暗紫色となりその基底部に黒色胞叢が多くなり、下顎に小歯が若干認められる。水槽の表層を活潑に泳ぎ廻り、盛んに摂餌する。孵化後 1 週間で体側にグアニン層の沈着が認められ始め、体色の変異はなお顕著で褐色系のものにはやや黒色胞が多くなり、胸緒・腹緒が黒みをおびて来る。水面で胸緒・腹緒を翼状に拡げ、尾部を細かく左右にふつて活潑に泳ぐが、この頃になると成長の早いものと遅いものとで体長の差が著しくなる。

ホソトビ： 全長 5.1 mm (孵化後 3 日, Fig. 14 F) ツクシトビウオとほぼ同様に各垂直緒は分化し、軟条の原基もほぼ定数に達するが、胸緒はまだ無色透明で、腹緒には緒条にそつて黒色胞が現われ始め、体色は一般に黒みをおび、腹部が殊に美しく、下顎には小歯を認める。孵化後 5 日位すると体側の黒色胞を増し、胸緒の成長がツクシトビウオに比して遅く、体側にグアニン胞が沈着し始める。

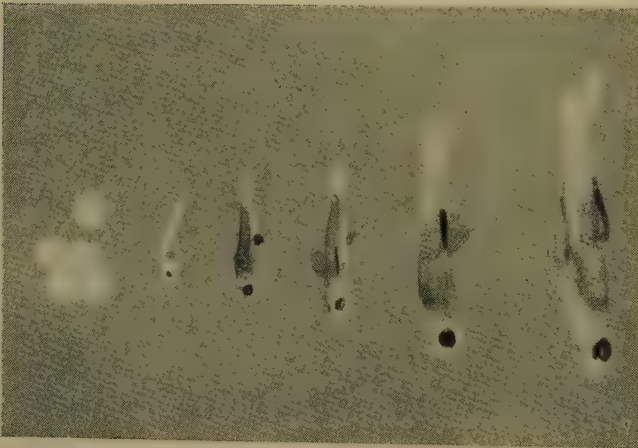


Fig. 10. Eggs, larvae and juveniles of *Cypselurus heterurus döderleini*.
× ca. 2



Fig. 11. Eggs, larvae and juveniles of *Cypselurus opisthopus hiraii*.
× ca. 2

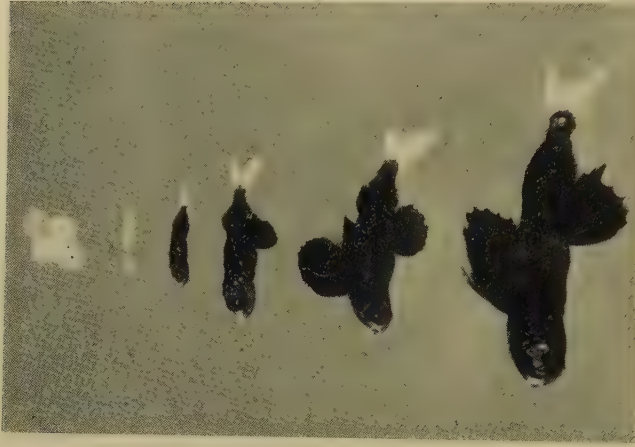


Fig. 12. Eggs, larvae and juveniles of *Cypselurus starksi*. × ca. 2

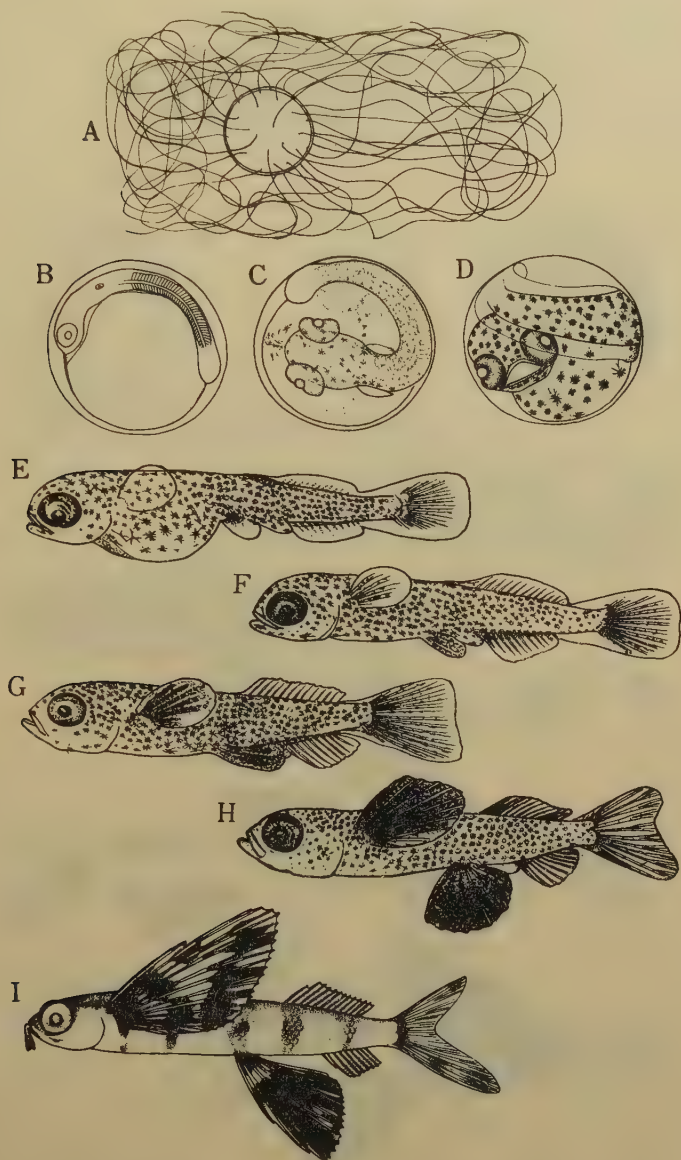


Fig. 13. Development of *Cypselurus heterurus döderleini*.

A. Egg (diam. 1.86 mm) with the attached filaments. B. Four days embryo (filaments have been removed). C. Ten days embryo. D. Two weeks embryo. E. Newly hatched larva, 6.3 mm in total length. F. Three days larva, 7.0 mm in total length. G. Fourteen days larva, 10 mm in total length. H. Twenty-five days larva, 14 mm in total length. I. Juvenile, 90 mm in total length.

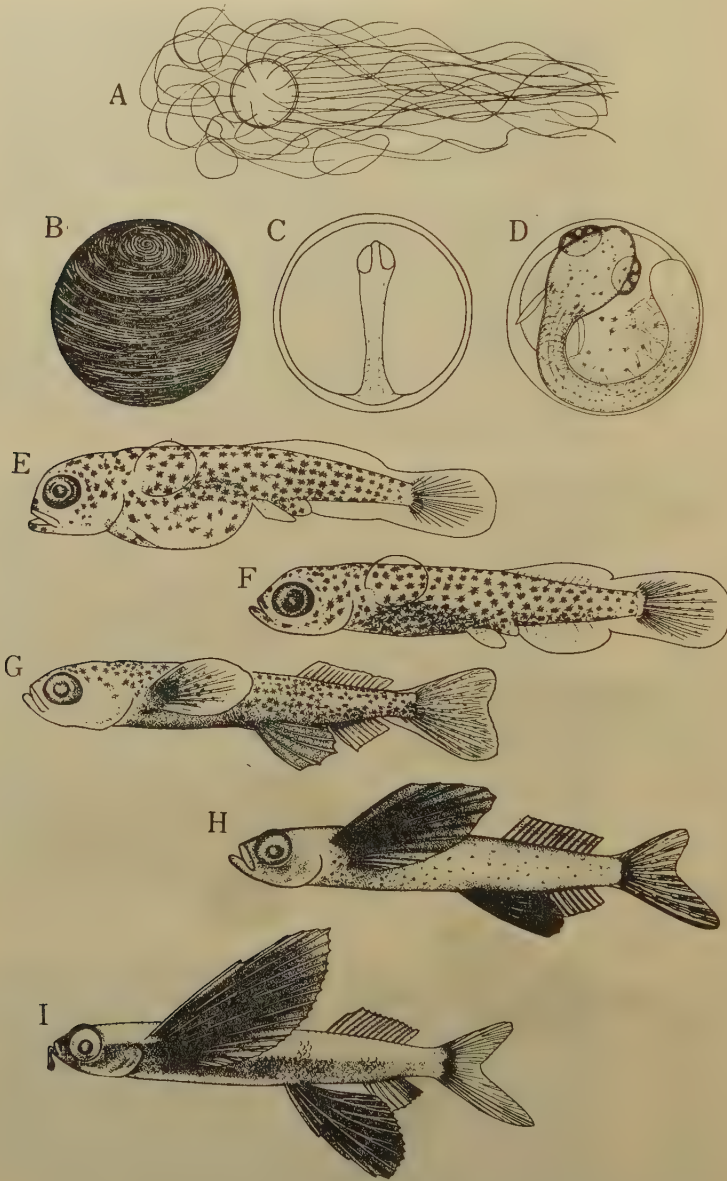


Fig. 14. Development of *Cypselurus opisthopus hirai*.

A. Egg (diam. 1.47 mm). B. Ripe ovarian egg. C. Two days embryo.
 D. Ten days embryo. E. Newly hatched larva, 4.7 mm in total length.
 F. Three days larva, 5.1 mm in total length. G. Twenty days larva,
 13 mm in total length. H. Thirty-five days larva, 23 mm in total length.
 I. Juvenile, 65 mm in total length.

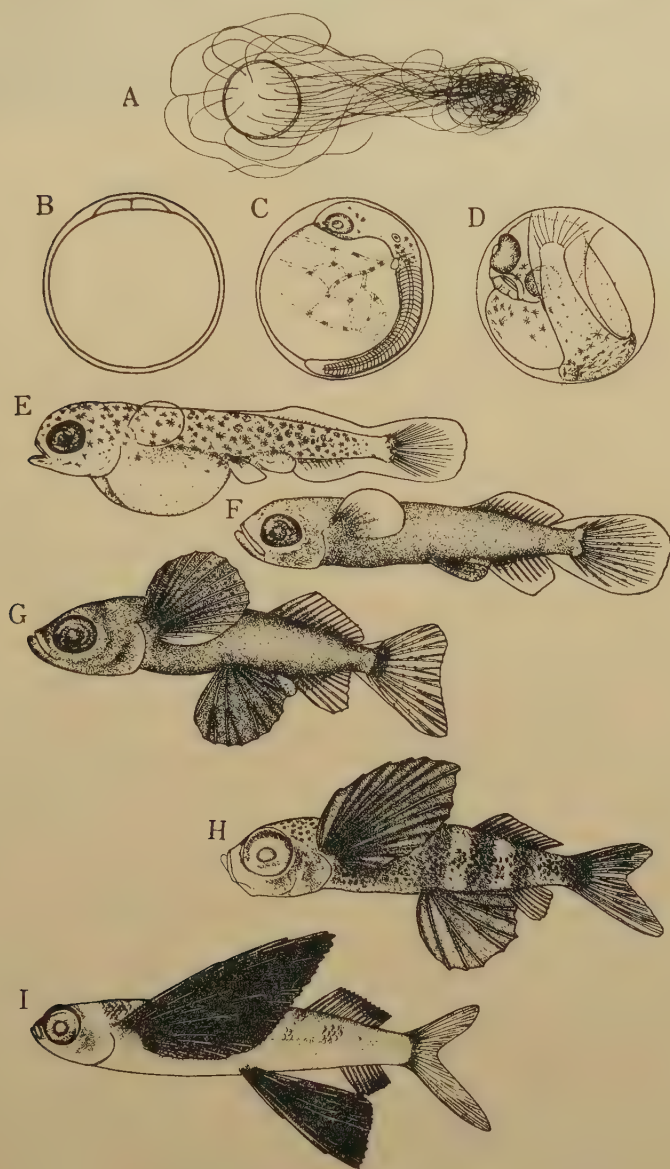


Fig. 15. Development of *Cypselurus starksi*.

A. Egg (diam. 1.66 mm).— B. Two hours embryo. C. Four days embryo. D. Six days embryo. E. Newly hatched larva, 4.4 mm in total length. F. Two days larva, 5.7 mm in total length. G. Ten days larva, 7.3 mm in total length. H. Fifty days larva, 20 mm in total length. I. Juvenile, 115 mm in total length.

アリアケトビウオ： 全長 5.7 mm (孵化後 3 日, Fig. 15 F) 卵黄が吸収しつくされる頃になると, 頭部の褐色の部分を残して体全面が黒くなる. 各垂直鰭は分化し, 軟条の原基も定数に達し, 腹鰭及び胸鰭の基部に黒色胞を生じ, 下顎に若干の歯を生ずる. 游泳はやはり余り活潑でないが, 餌は盛んに食べる. 孵化後 3, 4 日すると腹鰭の成長が顕著で, 体は他の 2 種に比して太短い.

天草におけるトビウオ類の研究

第4報 *Cypselurus* 属3種の生態・生活史

塚原 博・塩川 司・稲尾 正

Studies on the flying-fishes of the Amakusa Islands. Part 4.
The life histories and habits of three species
of the genus *Cypselurus*

Hiroshi Tsukahara, Tsukasa Shiokawa and Tadashi Inao

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天草におけるトビウオ類の研究¹⁾

第4報 *Cypselurus* 属3種の生態・生活史(2)²⁾

塚原 博・塩川 司・稲尾 正

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6. 稚 魚 期

ツクシトビウオ： 全長 10 mm (孵化後 14 日, Fig. 13 G) 胸鰭が伸長し, 赤褐色・黄褐色の色素胞が現われ, 表層・中層を活潑に泳ぎ廻る. 孵化後 20 日 で全長 12 mm 位になり胸鰭・腹鰭の色彩に個体差が著しく現われ, 黄・茶褐・黒褐・乳白色等の色調になる.

全長 14 mm (孵化後 25 日, Fig. 13 H) 胸鰭の先端は腹鰭の基底部後方にまで伸び, 尾鰭は叉形となつて下葉が伸長し始め, 水面上に飛びあがる習性が見られる. 全長 5~28 mm 程度の稚魚は流れ藻につく習性を有する.

全長 90 mm (Fig. 13 I) 体色は生時には黄金色をおび, 体側に銀白色で縁どられた 5 本の黒色の横縞が生じ, 胸鰭・腹鰭にも 鰭をたたんだ時体側の 斑紋に一致する 黒色帯を生ずる. 又下顎に外縁を黒く縁どつた美しい黄色の 1 対のひげを有するが, このひげは全長 15 mm 位のものから出来始める (Fig. 17).

この程度の大きさの稚魚は天草西岸に 6~8 月に多数出現し, 集魚灯下に集まる 習性があるので, たも網で容易に採集出来る. 灯下では胸鰭・腹鰭を拡げて水面を滑るように泳ぎ来つて, 時々尾部を彎曲して静止し, 或は潮流に乗つて泳ぎ去るが, 灯火を目がけて飛来することも屢々ある. 集魚灯下に来游するのはほとんど終夜見られるが, 午後 8~12 時の間が比較的多く, 又潮目の来る直前に多く, 数尾群をなして集まる傾向が見られる. この時期のものでは相当の飛翔能力を有する.

全長 15 cm 以上になると, 体色は成魚と同じく背部は青黒色, 腹部は銀白色となるが, 胸鰭は紫黒色になりその中央部に幅の広い透明帯を有し, 成魚同様の生活をする (Fig. 18).

ホソトビ： 全長 13 mm (孵化後 20 日, Fig. 14 G) 体は他の 2 種に比して細長く, 腹部が黒みをおび, 胸鰭の伸長が遅い. 游泳はツクシトビに比してやや不活潑である.

全長 23 mm (孵化後 35 日, Fig. 14 H) 胸鰭・腹鰭が伸長し, 黒ずんで来る. この頃までは流れ藻につき飛ぶ習性は見られないが, 全長 25 mm 以上のものでは飛翔能力があり,

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2) 日本水産学会秋期大会(長崎, 1955 年 10 月)にて講演.

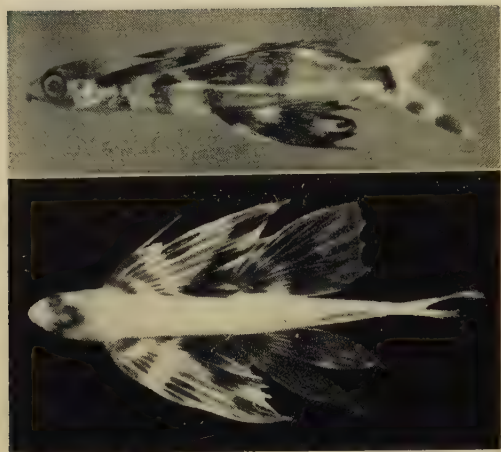


Fig. 16. Juvenile of *Cypselurus heterurus döderleini*. $\times 1$



Fig. 17. Dorsal view of barbel of lower jaw. $\times 6$



Fig. 18. Young of *Cypselurus heterurus döderleini*. Fork length 18 cm.

飼育中水面より 15 cm の高さの側壁を飛び越したものもあつた。天然では沿岸の表層を群をなして游泳する。

全長 65 mm (Fig. 14 I) 体は細長く、体色は銀青色で、体側下方に眼の後方より体の後端に達する幅の広い黒色の一条の縦縞が走り、臀鰭の後部が黒くなり、胸鰭・腹鰭は一様に暗色となる。又下顎には 1 個の花弁状の黒色のひげを有する (Fig. 20)。



Fig. 19. Juvenile of *Cypselurus opisthopus hiraii*. $\times 1$



Fig. 20. Dorsal view of barbel of lower jaw. $\times 5$

天草沿岸で6～7月に多く出現し、他のトビウオの稚魚同様集魚灯下に集まる習性を現わす。

アリアケトビウオ： 全長 7.3 mm (孵化後 10 日, Fig. 15 G) 体は他の 2 種に比して太短かく、眼が大きく、体色は一様に濃黒色になり、胸鰭下端を残して腹鰭とともに黒く、背鰭・臀鰭の基部も黒みをおびる。孵化後 20 日 全長 14 mm になると水面から飛びあがる習性が見られ始め、7 尾飼育中その 4 尾が水面より 15 cm 高い水槽の縁を飛び出したことがある。

全長 17.2 mm 体側の鱗が形成され、胸鰭・腹鰭及び体の全面は濃黒色であるが、頭部のみやや赤褐色をおびる。夜間は胸鰭・腹鰭を拡げて水面に静止しているが、体色は昼間と違い黒みがかつた乳白色をなす。全長 20 mm (Fig. 15 H) では黒い体色がやや淡くなり、後半部の体側に 3 条の横縞が認められる。

全長 115 mm (Fig. 15 I) 体色は背部が暗青緑色腹部は銀白色で、胸鰭・腹鰭は一様に黒く、背鰭・臀鰭は縁辺が黒みをおびる。下顎には生涯を通じてひげを生じない。この地方では 8～9 月 ツクシトビウオ・ホソトビの稚魚が少くなる頃出現するが、これらと同様集魚灯下に集まる習性を示す。

7. 成長と年令

これら 3 種のトビウオについて、この地方では産卵のため来遊した親魚と生まれた仔・稚魚、及びこれより南の海域で生まれ成育しつつ北上する稚魚及び若魚が 5～9 月に見られるのみで、周年に亘る各発育段階のものが継続的に採集出来ないで、この地方のみの採集資料からその成長を断定することは難しい。しかし 1955 年の調査で採集したものの Fork 長組成を月別に整理し、これに人工受精より孵化飼育したものを加えて図示すると

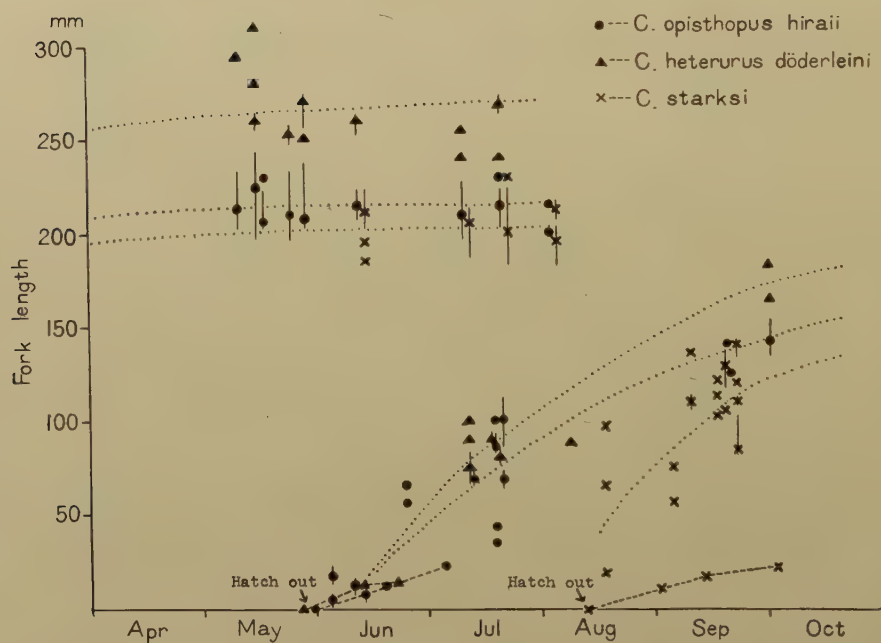
Fig. 21. Juvenile of *Cypselurus starksi*. $\times 1$ 

Fig. 22. Length-time distribution of larva, juvenile, half-grown and adult taken from Amakusa Islands.

— : range of fork length. ●▲× : mode of fork length.
 : growth curve in nature. - - - : growth curve in culture.

Fig. 22 になり、ほぼ3種の成長傾向がほぼ推定出来る。これによれば3種ともほぼ同様の成長を示し、成魚の大きさの違いに従ってツクシトビウオ・ホソトビ・アリアケトビ

ウオの順に成長速度が緩やかになっているが、3種とも比較的成長が早く、満1年で成魚に達する。産卵魚群についての検鱗の結果は第2報で報告したバシヨウトビウオの鱗とほぼ同様に、鱗の *circuli* に間隔の粗密は見られず、鱗も順調に成長して、その縁辺の近くにのみ顕著な *circuli* の乱れが生じ、その外側の鱗相は極めて薄くなっている。この点からも満1年で成熟し、産卵魚群の主体は満1年魚と考えられる。尚人工受精により孵化飼育したものは天然のものに較べて極めて成長が悪かった。Fig. 22 の Fork 長組成について、同じ時期に採集されたもので相当の大きさの変異が見られるのは、雌雄の成長度に差があること。産卵場が南北に相当の広がりがあり産卵期が比較的長いことなどによるものであらう。その年の発生群で9~10月頃に Fork 長 10~15 cm になったものは、五島・平戸（長崎県）方面において旋網、定置網で相当量漁獲されるが、これらは水温の下降とともに適温を追って南下し、翌年産卵のため5~7月に北上するのであらう。

8. 天草西岸のトビウオ漁業

天草西岸におけるトビウオ漁業は、毎年5月から7月にかけて産卵のため沿岸に来游する魚群を対象として行われている。漁法としては1・2屯の無動力船で2・3名の漁師により、アゴ網と云われる浮刺網を用いて行われる。この他沿岸の定置網及び敷網にも僅かに漁獲が見られる。アゴ網の構造は4本8節の綿糸網からなり、高さ2.25 m・長さ50 mのものを1反と称し、これを7・8反横に連結して操業する (Fig. 23)。この地方では化学繊維はまだ用いられていない。操業は夕刻に距岸4・5 湊の漁場へ出かけて、日没直前に潮の流れに対して直角の方向に一直線に投網し、潮流に流されながら適時網を見廻つて刺さつた魚をはずし夜明けまで終夜行ふ。網は常に真直ぐ張られていることが必要で、流れ藻がよく網にかかるが速かに除去する。漁業者によれば、日没及び月の出直後・夜明け前に漁獲が多く、潮目の接近或はイルカの群が網の岸側を通過した時は一時的に網に多く



Fig. 23. Our crew setting the gill nets.



Fig. 24. Drying the gill nets by fishermen.

かかり、小潮時より大潮時に漁獲が良いと云う。操業が沖合 4・5 哩より岸側で夜間行われるため、動力船の推進機で海中の網を切断される恐れが多く、近年は漁場も狭められ漁業者も減少している。天草西岸のアゴ網による漁獲高及び富岡漁業協同組合の水揚げ高を Table. 5 に示したが、このうち約 9 割をホソトビが占め、残りの約 1 割をアリアケトビウ

Table 5. Catches of flying fish by gill nets in Amakusa district.

Year	Catch of Tomioka region				Annual catch of Amakusa
	May	June	July	Total	
1950	1,200	750	0	1,950	—
1951	1,010	980	50	2,040	—
1952	1,500	1,150	100	2,750	4,290
1953	1,550	950	300	2,800	3,900
1954	750	150	0	900	1,600
1955	300	250	0	550	—

(Unit: Kan, 1 Kan=3.75 kg.)

オ・ツクシトビウオが占める(1955 年における漁獲物組成は、成魚についてホソトビ 92%, アリアケトビウオ 6%, ツクシトビウオ 2% であつた)。従つてホソトビの来游期である 5・6 月が盛漁期で、7 月上旬には急に減少してこの地方のトビウオ漁は終了する。漁業者によれば、トビウオの来游量には年により相当大きな変動があるとのことで、これは沿岸の産卵場所である藻場の条件による来游量の多寡とともに、対象魚群の大部分が 1 年魚であるため、前年度の発生群の消長が大きく影響するためであらう。又漁獲量の変動は漁期が梅雨時にかかるため、操業が天候に左右されることが大きい。この地方では漁獲物は多少

地元消費もあるが、大部分鮮魚として熊本方面に出荷され、加工は行われていない。又その年生まれた3種の未成魚は、五島・平戸地方で他のトビウオ類の未成魚とともに相当量漁獲されて、焼アゴ・干アゴとして重要であるが、この地方では漁獲されていない。

9. 摘 要

1) 天草西海岸においてトビウオ類の漁業生物学的調査を行い、トビウオ類13種を認めたが、漁業の対象となつているものはハマトビウオ属のホソトビ・アリアケトビウオ・ツクシトビウオで、そのうちホソトビが大部分を占めるが、これら3種の生態・生活史を明らかにした。

2) これら3種のうちツクシトビウオが最も大形で、ホソトビ・アリアケトビウオと小形になるが、これらは外観上は極めて類似する。しかし脊椎骨(ツクシトビウオ：47~49, ホソトビ：45~46, アリアケトビウオ：43~44)その他で区別出来る。

3) 天草西海岸には、ホソトビ・ツクシトビウオは5月上旬より8月上旬、アリアケトビウオは6月上旬より9月下旬に産卵のため来遊するが、雌魚に比して雄魚が多く、雌魚の体長は雄魚に比してやや大きい。

4) 浮刺網による漁獲試験の結果では、夜間における活動は日没とともに活潑となり、午後9時から11時の間に最も盛んで、これより日の出まで漸次減少する。又游泳方向と潮流との関係は、潮流の方向から網にささるものが多い。

5) 産卵の盛期は、ホソトビ・ツクシトビウオが5~7月、アリアケトビウオは7~8月で、人工受精による卵発生の観察及び孵化仔魚の飼育を行つた。孵化に要する時間は、ホソトビ・ツクシトビウオが約2週間(水温20~22°C)、アリアケトビウオが5~7日(水温26~28°C)であつた。

6) 卵は何れも沈性纏絡卵で球形をなし、約50本の長い纏絡糸を有する。卵径はツクシトビウオが平均1.86mmで最も大きく、アリアケトビウオが1.66mm、ホソトビが1.47mmで最も小さい。産卵は1回で、産卵数はツクシトビウオが平均9,580、ホソトビが5,890、アリアケトビウオは5,300である。

7) 仔稚魚には体色・斑紋等に3種の差が認められ、ツクシトビウオには下顎に1対の、ホソトビには1個のひげを生ずるが、アリアケトビウオにはひげを生じない。何れも群をなし、流れ藻及び集魚灯下に集まる習性が見られ、約1ヶ月で空中に飛びあがる習性を生ずる。

8) 3種ともその成長は速やかで、九州西岸の水温の下降とともにその年の発生群は適温を追つて南下し、満1年で成魚となり、翌年産卵のため来遊する。又漁獲の対象が満1年魚で、前年の発生及び成長量が次年の来遊量に直接影響して、漁獲に大きい変動を与えらると思われる。

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R é s u m é

In this paper the writers deal with the life history and habits of three species of the genus *Cypselurus*; *C. heterurus döderleini*, *C. opisthopus hiraii* and *C. starksi*. One of these, *C. opisthopus hiraii*, constitutes the most part of the flying-fish catch and is economically important on the Amakusa Islands in Kyushu. These adult fishes appear in this region from early May to late September for spawning, and the fishing is carried out in the coastal waters with the gill net from May to July. In external appearance the differences of these species are slight, although they are distinguishable from the vertebral count: 47—49 (including urostyle) in *C. heterurus döderleini*, 45—46 in *C. opisthopus hiraii* and 43—44 in *C. starksi*.

Most of the fish for this study were taken with the gill net, and the young, juvenile and larval forms were captured mainly by a dip net with the aid of flood light at night. We have studied on various items, throughout the fishing season, as the vertical distribution, aggregation density and movement of the flying fish during the night-time. In every species the distribution is limited to the upper surface layer, its lower limit seldom exceeding 3 meters in depth. For example the vertical distribution and movement of *C. opisthopus hiraii* are given in Fig. 5. It should be noted that this species occurred in great abundance between the water surface and 50 centimeter layer and showed a more or less continuous vertical distribution. The upward movement commenced just after sun-set and the density became maximum from 9.00 to 11.00 p. m., and by 1.00 a. m. it begun to descend and was quite decreased before sunrise. The majority of the captured fish were impelled with the direct current toward the gill nets. The caught samples showed a predominance of males.

The spawning of *C. heterurus döderleini* and *C. opisthopus hiraii* takes place in May, June and July and that of *C. starksi* is later than the others. The number of eggs carried from an adult female of *C. heterurus döderleini* varied from about 8,500 to 10,000, of *C. opisthopus hiraii* from about 4,000 to 7,500 and of *C. starksi* from about 4,000 to 8,000. The eggs are spherical with about 50 long tendrils distributed over the whole surface. The oil globule is absent. The difference of the eggs of these three species is slight in external appearance, but the size is different on average: 1.86 mm in diameters in *C. heterurus döderleini*, 1.66 mm in *C. starksi* and 1.47 mm in *C. opisthopus hiraii*. The eggs were stripped and inseminated easily with the milt from the male and the embryonic development was observed. The incubation of *C. heterurus döderleini* and *C. opisthopus hiraii* required about 2 weeks at 20°–22° C water temperature, and of *C. starksi* about 5–7 days at 26°–28° C. The hatch-out took place several hours after the sun-set and at once they can swim under their own power close to the water surface. In the aquarium the hatched larvae were reared, with the nauplii of brine shrimp. Those of various developmental stages were captured from the sea. They were described and figured (Fig. 13, 14, 15). In about 3 days the larvae showed a tendency to attach to the seaweeds (Fig. 9), in about one month they occasionally made short, sporadic flights and surface skips. In the developmental stages of these species, there are differences in the shape of body, and also in the distribution of pigment over the body and fins. In the juvenile stages, *C. heterurus döderleini* has a pair of yellow barbels with the outer black flap, and *C. opisthopus hiraii* has a black single barbel, but *C. starksi* has not a barbel at all on the lower jaw (Fig. 17, 20). The larva, juvenile and half-grown fish are found in this region from early June to early October.

These young have a tendency to leave this region to migrate towards the southern waters in autumn. According to the plotting frequency distribution of the various body sizes, their growth is very rapid and they require one year to reach their sexual maturity and the commercial size (Fig. 22). The great fluctuation of commercial catch seems to be due to the occasional production of one year's class composing most of the catch.

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煉製品の鮮度保持に関する研究 II

Ethyl gallate, Gallic acid, 包装,
赤外線及び紫外線の効果

富山哲夫・米 康夫・原田悠三

Studies on method for keeping quality of "Kamaboko",
a cooked fish paste II

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I. 緒 言

著者等は第1報¹⁾で板付無糖蒲鉾を用い、各種防腐剤、セロファン包装、赤外線及び紫外線照射の鮮度保持効果について吟味し、紫外線及び赤外線照射の有効なこと及びセロファン包装が二次的汚染の防止に有効なことにつき報告した。しかし蒲鉾の表面に塗布した防腐剤は殆んど無効であり、特に防腐剤の塗布後直ちにセロファン包装したものは、無処理の対照より却つて微生物が多発することに注意し、恐らく蒲鉾の表面が細菌の発育に適した水分を保持したためと推定した。依てもし防腐剤を蒲鉾に練り込んだならば、防腐剤及び包装の効果が増大するであろう。本研究では Ethyl gallate 及び Gallic acid を蒲鉾に練り込んだ場合のセロファン包装、赤外線及び紫外線の効果について検討した。

II. 実験方法

a) 試料の調製及び放置条件：試験に用いた蒲鉾は無糖板付のもので、大略搥碎肉 90～94%，馬鈴薯澱粉 5～9%，食塩 1% 其他味の素、サッカリン少量より成り、業者の製造したものである。試験区は防腐剤水溶液をよく混和して製造し、対照区は試験区と同一水分量となる様に調節して製造した。試料の保持は飽和湿度としたブリキ缶内に 20～30 本の試料を入れ、蓋をして 26℃ の恒温器内に放置した。

b) 防腐剤の種類：供試したものは Ethyl gallate 及び Gallic acid である。肉糊量 100 g に対し 0.1, 0.04, 0.02, 0.01 g の防腐剤をそれぞれ 16.6 cc の水に溶かした溶液を混和した。

c) 紫外線及び赤外線照射方法：紫外線の照射には マツダ 或は シマダ の 15 W の低圧殺菌燈を用い、赤外線の照射は マツダ の 500 W-S 型のものを用い、30 cm の距離から上面を 5 分間、側面を 3 分間宛、前後面を 2 分間宛、計 15 分間照射した。但し紫外線照射

* 本研究の要は 1952 年 4 月に東京に於ける日本水産学会年会で発表した。

は毎日 1 回，赤外線照射は実験開始の時 1 回行つた。

d) 包装の種類及び方法：セロファンは予め紫外灯で照射して殺菌したものをうい，蒸煮後蒲鉾の全面を完全に包んだ。

e) 鮮度の判定：鮮度は主として官能検査によつたが，試験中蒲鉾の表層 1 cm 厚の肉をとり，十分に搗碎した後にその揮発性塩基を定量した。定量法は富山，原田の高温減圧法²⁾によつた。

III. 実 験 結 果

1. 防腐剤の効果及びセロファン包装の効果

無包装の場合における防腐剤の効果は Table 1 に示してある。これをみると，Ethyl gallate 及び Gallic acid はいずれも無処理の対照区と差なく，2 日後に微生物が多少認められ，その後の微生物の発育にも差がなかつた。Ethyl gallate を混和したものの揮発塩基は対照より少いが，顕著な効果は認められなかつた。セロファン包装した場合に於ける防腐剤の効果は Table 2 に示してある。セロファン包装の効果を見ると，無処理の対照は 2 日後に微生物が発生したのに対し，セロファン包装のみしたものは 3 日後に微生物が発生した。特に対照に比して微生物の発育は緩慢であり，また揮発塩基は対照が 96 時間後に 22.0 mg %，120 時間後 27.9 mg % であつたのに対し，セロファン包装のみのものは 96 時間後 11.6 mg %，120 時間後 20.6 mg % で，明らかに二次的汚染防止効果が認められた。防腐剤とセロファン包装を併用したものの効果はセロファン包装のみのものより多少変敗が早く，防腐剤の効果は認められなかつた。また防腐剤を添加したものは無包装と包装のいずれの場合も蒸煮すると僅かに変色した。

2. 赤外線及び防腐剤の効果

防腐剤を練り込み，成形後蒸煮した蒲鉾に 1 回だけ赤外線を照射し，赤外線の効果及び赤外線と防腐剤の併用効果について検討した。その結果は Table 3 に示す通りで，赤外

Table 1. Effectiveness of ethyl gallate and gallic acid to keeping quality of "Kamaboko" without casing. (Feb. 21 '52~25)

Time on incubation at 26°C		48			72				96			
Chemicals %	Quality	“Neto”*	Fungi	Odor	“Neto”	Fungi	Odor	V.B.N mg %	“Neto”	Fungi	Odor	V.B.N. mg %
None		—	±	±	+	+	+	10.6	±	±	+	22.0
Ethyl gallate	0.04	—	±	±	+	+	+	9.8	+	±	+	18.9
	0.02	—	±	±	+	+	+	10.2	+	±	+	15.1
	0.01	—	±	±	+	+	+	10.6	+	±	+	14.2
Gallic acid	0.1	—	±	±	+	+	+	12.4	+	±	+	20.1
	0.04	—	±	±	+	+	+	11.0	+	±	+	17.8
	0.02	—	±	±	+	+	+	16.4	+	±	+	27.2
	0.01	—	±	±	+	+	+	12.5	+	±	+	16.8

* Colonies of mucilagenous bacteria.

Volatile basic nitrogen was measured according to TOMIYAMA and HARADA's method 2).

Table 2. Effectiveness of casing and chemicals to keeping quality of "Kamaboko". (Feb. 21 '52~26)

Time on incubation at 26°C			48		72		96		120				
Chem- icals	Quality		“Neto”	Fungi	“Neto”	Fungi	V.B.N mg %	“Neto”	Fungi	V.B.N mg %	“Neto”	Fungi	V.B.N mg %
	Casing with cover	without											
Ethyl gallate	None	×	—	±	±	±	10.6	±	±	22.0	±	±	27.9
	None	○	—	—	±	±	8.7	±	±	11.6	±	±	20.6
	0.04	○	—	—	±	±	9.0	±	±	18.8	±	±	
	0.02	○	—	—	±	±	10.3	±	±	13.9	±	±	
	0.01	○	—	—	±	±	10.2	±	±	14.7	+	+	
	0.1	○	—	—	±	±	9.8	±	±	14.0	+	+	27.5
Gallic acid	0.04	○	—	—	±	±	9.2	±	±	20.8	±	+	
	0.02	○	—	—	±	±	10.9	±	±	24.0	±	+	
	0.01	○	—	—	±	±	9.6	±	±	22.9	±	+	28.0

The casing was carried out after steaming.

Table 3. Effect of combination of infrared ray and preservatives on shelf life of "Kamaboko". (Feb. 21 '52~26)

Time on incubation at 26°C			48			72			96			120					
Quality			“Neto”			“Neto”			“Neto”			“Neto”					
Treatment			Fungi	Odor		Fungi	Odor	V.B.N mg %	Fungi	Odor	V.B.N mg %	Fungi	Odor	V.B.N mg %			
Irradiation by infrared ray*	None	Ethyl gallate Gallic acid	—	±	—	±	±	±	10.6	±	±	+	22.0	±	±	+	27.9
			—	—	—	—	—	—	9.6	+	+	+	22.9	±	±	+	
	0.04		—	—	—	—	—	—	8.0	+	+	+	12.8	±	±	+	
	0.02		—	—	—	—	—	—	10.0	+	+	+	15.7	±	±	+	
	0.01		—	—	—	—	—	—	10.1	+	+	+	14.4	±	±	+	
	0.1		—	—	—	—	±	—	11.2	+	+	+	20.9	±	±	+	
	0.04		—	—	—	—	±	—	11.0	+	+	+	19.5	±	±	+	
	0.02		—	—	—	—	—	—	14.7	+	+	+	25.7	±	±	+	
	0.01		—	—	—	—	—	—	12.2	+	+	+	21.8	±	±	+	

* Irradiated for 5 minutes on the upper part, 3 minutes on the long sides and 2 minutes on both short sides. The irradiation was carried out only once at the start of the experiment with a 500-W infrared ray lamp at a 30cm distance.

線照射区は4日後に微生物が多発し、無処理の対照が2日後に微生物が認められたのに比すと、明らかに官能検査では有効であった。しかし揮発性塩基では対照と差が認められなかった。防腐剤と赤外線とを併用したものの効果は Table 3 及び Fig. 1a に示すように赤外線のみ照射したものと殆んど差がなく、防腐剤の効果は認められなかった。

3. 紫外線、防腐剤及びセロファン包装の効果

防腐剤を練り込んだ無包装蒲鉾に毎日紫外線を照射して放置中の変化を官能検査及び揮発性塩基により追跡した結果を Table 4 及び Fig. 1a に示した。紫外線照射区はいずれ

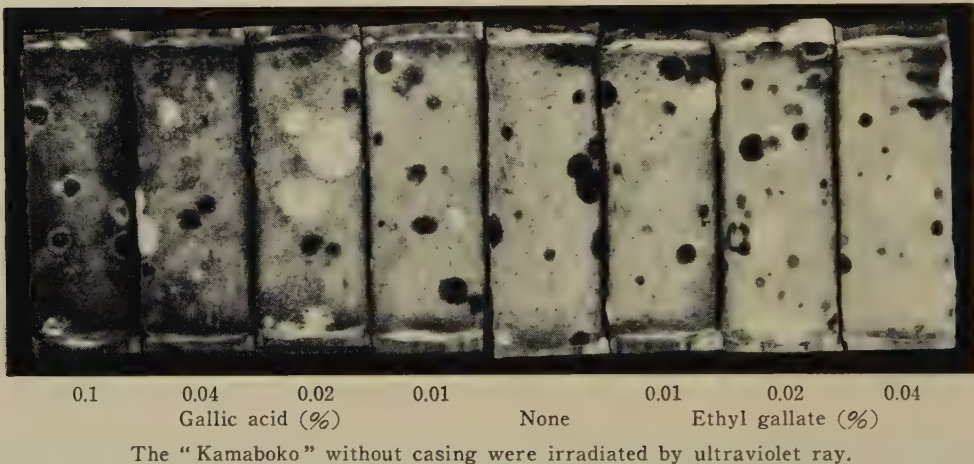
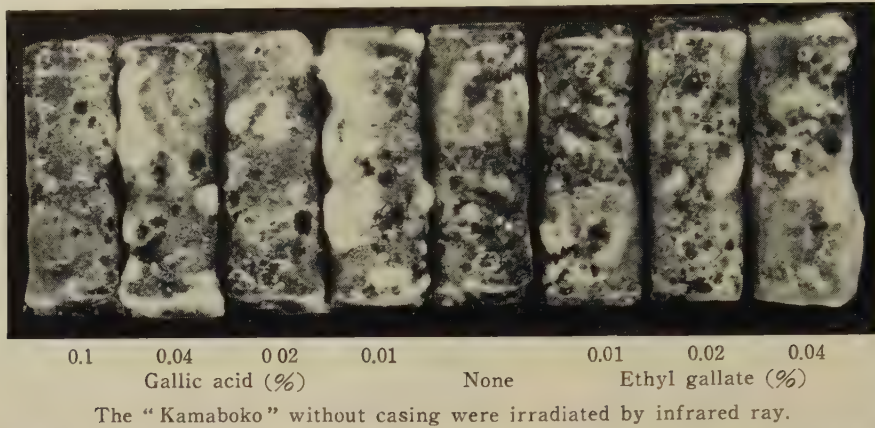
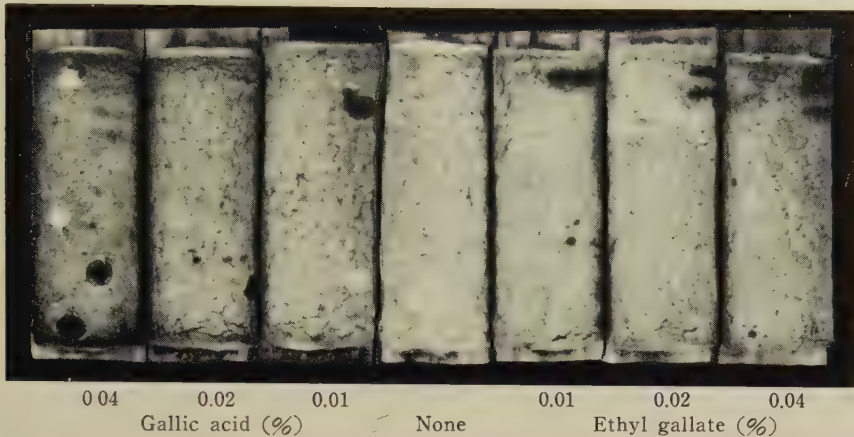


Fig. 1 a. The effectiveness of preservatives, infrared ray and ultraviolet ray to keeping quality of "Kamaboko".

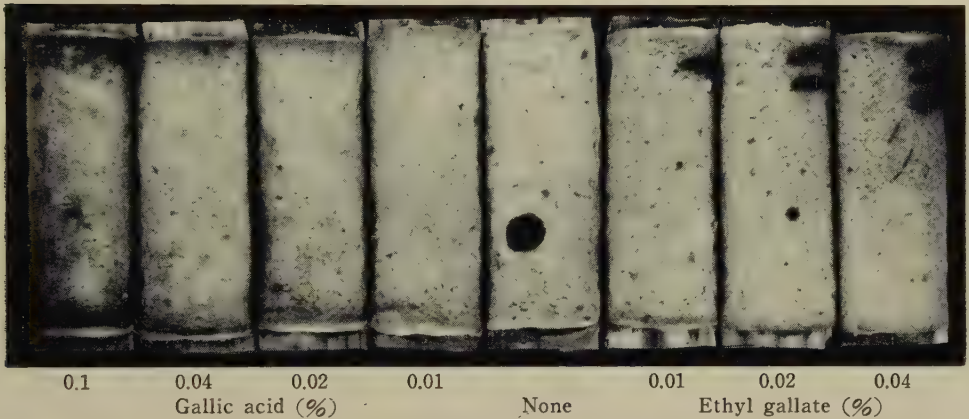
After 144 hrs, incubated at 26°C.

も 26°C で 4 日間鮮度を保持した。5 日後の揮発塩基をみると、対照区の 27.9 mg % に対し、紫外線照射区では 12.2 ~ 16.9 mg % であつて、紫外線照射は顕著な鮮度保持効果を示した。この場合も防腐剤の効果は全く認められなかつた。セロファン包装した場合の防腐剤及び紫外線の効果は Table 5 及び Fig. 1 b に示す通りで、Ethyl gallate と紫外線とを併用したものの中で Ethyl gallate 0.04 % 及び 0.02 % 区が最も有効で、26°C で 6 日間鮮度を保持した。次いで Ethyl gallate 0.01 % 区、Gallic acid 0.01 % 区が 5 日間、紫外線のみ照射したものが 4 日間鮮度を保持した。Gallic acid を 0.1, 0.04, 0.02 % 添加したものは紫外線のみ照射したものより多少悪かつた。

4. セロファン包装、赤外線、紫外線及び防腐剤を併用した場合の効果
防腐剤、赤外線、紫外線及び包装を併用した場合に、どの程度の効果があるかを知る目的で次のような実験を行つた。



The cellophane-covered "Kamaboko" were irradiated by ultraviolet ray and infrared ray.



The cellophane-covered "Kamaboko" were irradiated by ultraviolet ray.

Fig. 1 b. The effectiveness of preservatives, casing, infrared ray and ultraviolet ray to keeping quality of "Kamaboko".

After 144 hrs, incubated at 26° C.

業者の製造した肉糊に Ethyl gallate 或いは Gallic acid の水溶液をそれぞれ添加し混和した後、成形、蒸煮したものに赤外線照射し、直ちにセロファン包装後紫外線を照射した。なお紫外線照射は毎日1回繰返して行つた。防腐試験の結果は Table 6 及び Fig. 1 b に示す通りで、包装一赤・紫外線照射区は6日後に僅かに細菌が繁殖したに過ぎなかつた。他方 Ethyl gallate を練り込んだものはいずれも7日後に微生物が繁殖し始めた程度で最も有効であつた。これに反し Gallic acid を添加したものは無添加の包装一赤・紫外線照射区より多少悪かつた。以上の結果を総合してみると、セロファン包装、赤外線及び紫外線併用は明らかに有効であることが認められた。防腐剤の中では Ethyl gallate が包装及び紫外線照射と併用した場合に有効である。しかし Ethyl gallate と Gallic acid はいずれも蒲鉾に練り込んだ後、蒸煮すると Fig. 1 に示すように灰色とな

Table 4. Effect of combination of ultraviolet ray and preservatives on shelf life of "Kamaboko". (Feb. 21 '52~27)

Time on incubation at 26°C		48				72				96				120				144			
Quality																					
Treatment		"Neto"				"Neto"				"Neto"				"Neto"				"Neto"			
		Fungi	Odor			Fungi	Odor	V.B.N mg %		Fungi	Odor	V.B.N mg %		Fungi	Odor	V.B.N mg %		Fungi	Odor	V.B.N mg %	
Irradiated all over the surface	None	—	±	—		±	±	±	10.6	±	±	±	22.0	±	±	±	27.9				
	None	—	—	—		—	—	—	8.0	—	—	—	9.5	±	±	—	12.3	+	+	+	15.0
	Ethyl gallate	0.04	—	—	—	—	—	—		—	—	—		±	±	±	12.0	+	+	+	20.1
		0.02	—	—	—	—	—	—		—	—	—	11.5	±	±	±	12.2	+	+	+	16.0
		0.01	—	—	—	—	—	—	8.0	—	—	—	12.3	±	±	±	14.0	+	+	+	17.8
	Gallic acid	0.1	—	—	—	—	—	—	8.9	—	—	—	11.7	±	±	±	12.2	+	+	+	27.0
		0.04	—	—	—	—	—	—		—	—	—		±	±	±	16.9	+	+	+	
		0.02	—	—	—	—	—	—		—	—	—		±	±	±	15.3	+	+	+	
		0.01	—	—	—	—	—	—	9.0	—	—	—	12.6	±	±	—	15.0	+	+	+	27.3

Irradiated for 5 minutes on the upper part, 3 minutes on the long sides and 2 minutes on both short sides. The irradiation was carried out daily with a 15-W ultraviolet ray lamp at a 30 cm distance.

Table 5. Effect of ultraviolet ray and preservatives on shelf life of cellophane-covered "Kamaboko". (Feb. 21 '52~28)

Time on incubation at 26°C		72				96				120				144				168			
Quality																					
Treatment		"Neto"				"Neto"				"Neto"				"Neto"				"Neto"			
		Fungi	Odor			Fungi	Odor	V.B.N mg %		Fungi	Odor	V.B.N mg %		Fungi	Odor	V.B.N mg %		Fungi	Odor	V.B.N mg %	
Irradiation by ultraviolet ray*	None	—	—			—	—			±	—	12.9		±	±	17.8		+	+		27.0
	Ethyl gallate	0.04	—	—		—	—			—	—	9.0		—	—	10.9		±	—		17.0
		0.02	—	—		—	—			—	—	10.0		—	—	11.1		±	—		15.0
		0.01	—	—		—	—			—	—	10.9		±	±	12.9		+	+		
	Gallic acid	0.1	—	—		—	—			±	±	16.5		+	+	19.0		±	±		
		0.04	—	—		—	—			±	±	17.5		+	±	22.0		+	+		
		0.02	—	—		—	—	11.0		±	—	15.4		+	—	17.9		+	+		
		0.01	—	—		—	—			—	—	13.3		±	—	15.9		+	—		25.8

* treated in the same way as shown in Table 4.

り、商品価値を減ずるので今後は適当な防腐剤の探究が必要である。適当な防腐剤が得られれば、包装と赤外線及び紫外線とを併用することによつて蒲鉾の鮮度保持が解決されるであろう。

IV. 総 括

1. 無包装の無糖板付蒲鉾に Ethyl gallate 及び Gallic acid を練り込んだところ、鮮度保持効果は認められなかつた。

2. セロファンで全面を覆うた蒲鉾の鮮度保持日数は対照の 2 日に対し 3 日であり、特に微生物の発育は緩慢で、明らかにセロファンの二次的汚染防止効果が認められた。

Table 6. Effect of combination of infrared ray, ultraviolet ray, preservatives and casing on shelf life of "Kamaboko".* (Feb. 21 '52~28)

Time on incubation at 26°C		96			120			144			168		
Chemicals	Quality	"Neto"	Fungi	V.B.N mg %	"Neto"	Fungi	V.B.N mg %	"Neto"	Fungi	V.B.N mg %	"Neto"	Fungi	V.B.N mg %
None		—	—	9.7	—	—	12.9	±	—	16.9	+	—	
Ethyl gallate	0.04	—	—		—	—	12.1	—	—	14.0	±	±	25.9
	0.02	—	—		—	—		—	—	13.0	±	±	19.8
	0.01	—	—		—	—		—	—	13.0	±	±	18.5
Gallic acid	0.1	—	—	14.5	—	—	15.7	±	±	19.0	±	±	
	0.04	—	—	14.4	—	—	16.7	±	±	21.0	±	±	22.0
	0.02	—	—		—	—		±	±		±	±	
	0.01	—	—	15.8	—	—	16.2	±	±	18.2	±	±	

* Sample was subjected to a 15 minutes irradiation with infrared ray just after the application of chemicals, and then covered with cellophane and irradiated by a 15-W ultraviolet ray lamp at a 30 cm distance. The ultraviolet ray irradiation was carried out daily and in the same way as shown in Table 4.

3. セロファン包装した場合は Ethyl gallate 及び Gallic acid の効果は全く認められなかった。

4. 赤外線を無包装の蒲鉾の全面に 15 分間 1 回照射したものの鮮度保持日数は 26°C で対照の 2 日に対し 4 日で、赤外線照射は明らかに鮮度保持効果を示した。防腐剤を練り込んだ蒲鉾に赤外線を照射した場合は、防腐剤の効果は認められなかった。

5. 無包装の蒲鉾の全面に紫外線を毎日 15 分間照射したところ、5 日間鮮度を保持した。防腐剤を練り込んだ無包装の蒲鉾に紫外線を照射した場合、防腐剤の効果は全く認められなかった。

6. 0.04% 及び 0.02% の Ethyl gallate を練り込んだ蒲鉾にセロファン包装をして紫外線を照射したものは最も有効で、対照が 2 日であつたのに対し 7 日間鮮度を保持した。次いで 0.01% Ethyl gallate 或いは 0.01% Gallic acid を練り込み紫外線を照射したものの、次に紫外線照射のみのものの順に有効であつた。

7. 防腐剤を練り込んだ蒲鉾に赤外線を照射し、更にセロファンで包装したものを紫外線で毎日照射したところ、無処理の対照が 2 日、防腐剤を用いず包装して赤外線及び紫外線を照射したものが 6 日間鮮度を保持したのに対し、Ethyl gallate を練り込んで包装し赤外線及び紫外線を照射したものは最も有効で 7 日間鮮度を保持した。他方 Gallic acid は全く無効であつた。

本研究の一部は厚生省科学研究費（主任研究者 佐々木林治郎教授）により支弁した。

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R é s u m é

In preceding report¹⁾ it was shown that most preservatives when applied on the surface were not effective to prolonging the shelf life. It was further noticed that a group in which the casing was made just after the treatment with preservatives showed rather a shorter storage life than the control group without casing. The present paper deals with the effectiveness of preservatives which were added to the paste before steaming, casing, infrared and/or ultraviolet ray on the keeping quality of "Kamaboko".

1. Ethyl gallate and gallic acid which were added to "Kamaboko" with or without casing were ineffective (See Tables 1 and 2).

2. The casing with cellophane film was effective to prolonging the shelf life as long as three days in contrast to two days in the control group without casing and was effective to the elimination of the secondary contamination (See Table 2).

3. Irradiation by infrared ray all over the surface of the "Kamaboko" without casing was able to prolong the shelf life to four days as contrasted to two days in the control group without irradiation. The combination of the irradiation with preservatives gave no improvement (See Table 3 and Fig. 1a).

4. Daily irradiation by ultraviolet ray all over the surface of the "Kamaboko" without casing was effective to the prolongation of the shelf life to five days as contrasted to two days in the control group without casing. The combination of this irradiation with preservatives gave no improvement (See Table 4 and Fig. 1a).

5. Daily irradiation by ultraviolet ray all over the surface of cellophane-covered "Kamaboko" which contained ethyl gallate at 0.02 or 0.04 % level was effective to prolonging the shelf life as long as seven days in contrast to two days in the control group without casing (See Table 5. and Fig. 1b).

6. Daily irradiation by ultraviolet ray all over the surface of the cellophane-covered "Kamaboko" which contained ethyl gallate and was irradiated with infrared ray just after being prepared was able to prolong the shelf life to seven days in contrast to two days in the control group without casing (See Table 6 and Fig. 1b).

Department of Fisheries, Faculty of Agriculture,
Kyushu University



煉製品の鮮度保持に関する研究 III

数種防腐剤, 被覆, 赤外線及び紫外線照射
の効果並びにそれらの組合せの
効果について

富山 哲夫・米 康 夫

Studies on methods for keeping quality of "Kamaboko",
a cooked fish paste III

Effectiveness of chemical and physical treatments
on the shelf-life of "Kamaboko"

Tetuo Tomiyama and Yasuo Yone

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I. 緒 言

著者等¹⁾²⁾はセロファン包装, 赤外線及び紫外線による処理は蒲鉾の鮮度保持に顕著な効果を示すこと, 特に之等の物理的手段を相互に併用すると単独の場合に比し更に鮮度保持効果が増大することを報告した。また種々の防腐剤と物理的手段とを併用した場合の防腐剤の効果について検討したが, 優秀な防腐剤は発見できなかつた。また防腐剤とセロファン包装を併用した場合, 防腐剤を蒲鉾の表面に塗布したものは無処理の対照に比して却つて微生物が多発した。しかし防腐剤を練り込んだ場合には対照より悪化することはなかつた。

最近 DHA, 粗製第四級アミン等を入手したので, 表面塗布した場合と練り込んだ場合との効果を比較した。また包装方法, 紫外線及び赤外線の照射方法等について検討し, 更に之等の最適方法の組合せを実施した結果, 26°C で少くとも 10 日間は鮮度を保持できることを確かめたので, ここに概要を報告する。

II. 研 究 方 法

(a) 試料の調製及び放置条件: 試験に用いた蒲鉾は無糖板付のもので, 大略搗碎肉 90 ~ 94 %, 馬鈴薯澱粉 5 ~ 9 %, 食塩 1 % 其他味の素, サッカリン少量より成り, 業者の製造したものである。試験区は防腐剤溶液或は粉末を搗碎時に混和した場合と成形後防腐剤を表面に塗布した場合とを設けた。一方, 対照区は試験区と同一水分量となる様に調節した。それぞれ成形した後コッホ殺菌釜の上部の温度が 90°C を示す条件で 20 分間蒸煮した。試料の保持は大形のブリキ缶に 20 ~ 30 本の試料及び水を入れたパットを入れ, 蓋をして 26°C の恒温器内に放置した。この条件では缶内の湿度は 100 % であつた。

(b) 防腐剤の種類: 供試したものは DHA (Dehydroacetic acid, 和光純薬試供品),

* 本研究の大要は 1952 年 9 月に函館に於ける日本水産学会北海道大会で発表した。

DHA-Na 塩, 第四級アミン QA(BB) (日本油脂研究所製造の日産カチオン BB で有効成分 30% のもの), パラオキシ安息香酸ブチルエステル POB (吉富製薬製) サリチル酸アミド SA (吉富製薬製) である。

(c) 紫外線及び赤外線照射方法: 紫外線の照射にはマツダ或はシマダの 15 W の低圧殺菌燈を用い, 30 cm の距離で, 蒲鉾の上面を 7 分間, 側面を 2 分間宛, 前後面を 2 分間宛, 計 15 分間照射した。また 1 日 1 回の場合及び 8 時間をおいて 1 日 2 回照射の場合の効果をも吟味した。赤外線の照射はマツダの 500 W-S 型のものを 30 cm の距離から上面のみ 10 分間行つた。

(d) 包装の種類及び方法: セロファンは予め紫外灯に照射して殺菌したものを用い, 全面を完全に包むように注意した。ポリビニールアルコール PVA は日本合成化学工業 K・K のもの, 醋酸ビニール VAC は和光純薬 K・K のものを用い, いずれもブラッシで蒲鉾の表面に薄く塗布した。

(e) 鮮度の判定: 鮮度は主として官能検査によつたが, 試験終了後に揮発性塩基, 揮発酸及び著者等³⁾が提案したカタラーゼ法による鮮度の判定を行つた。本研究に於て用いたカタラーゼ法には試料表面の約 5 mm 厚さの薄層を 1 cm 径の円形に打ち抜いたもの 2 枚を用い, これを 5 cc の 3% H_2O_2 と反応させ 5 分間に発生した O_2 量を水銀圧力計の読みであらわし, この値で汚染度を示した。その後, 表面の洗滌水を試料とするよう改変したが, 本研究では前者によつた。揮発塩基の定量は富山, 原田の高温減圧法⁴⁾により, 揮発酸の定量は FRIEDMAN 法⁵⁾によつた。

III. 実験結果及び考察

1. 塗布した場合と練り込んだ場合の防腐剤の効果の比較

0.2% DHA, DHA-Na 及び第四級アミン QA(BB) を蒲鉾の表面に塗布した場合の効果は Table 1 に示す通りで, DHA 及び DHA-Na は効果が全く認められなかつたが, 第四級アミン QA(BB) は DHA 及び DHA-Na と同じ濃度で多少効果が認められ対照では 24 時間後に細菌が多発したのに対し, 1% QA(BB) では 48 時間後に細菌及びカビ

Table 1. Effectiveness of preservatives which were smeared on the surface of "Kamaboko" to its shelf life. (April 10 '52~12)

Time on incubation at 25°C (hr)		24			48		
Chemicals %	Quality	"Neto"	Fungi	Odor	"Neto"	Fungi	Odor
None		+	—	+	++	±	+
DHA*	0.2	+	—	+	++	±	+
DHA-Na**	0.2	+	—	+	++	±	+
QA(BB)***	1.0	—	—	—	±	±	—
	0.2	±	—	±	++	±	+

* Dehydroacetic acid ** Sodium salt of dehydroacetic acid *** Quaternary ammonium compound (30% purity)

Table 2. Effectiveness of preservatives which were mixed in "Kamaboko" to its shelf life.

Time on incubation at 26°C (hr.)		48	72				96	120				144			
Chemicals %	Quality	"Neto"		"Neto"		Catalase activity†	"Neto"		"Neto"		Catalase activity	"Neto"		"Neto"	
		Fungi	Odor	Fungi	Odor		Fungi	Odor	Fungi	Odor		Fungi	Odor	Fungi	Odor
I *	None	—	—	—	+	+	+	+	+	+	+	+	+	+	+
	DHA 0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	DHA-Na 0.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	QA(BB) 0.2	—	—	—	—	+	—	—	—	+	—	—	+	—	+
II **	None	+	±	+	+	36	+	+	+	+	+	+	+	+	+
	DHA 0.2	—	—	—	—	—	—	—	—	—	0.5	—	—	—	10
	DHA-Na 0.2	—	—	—	—	3	±	—	—	3	+	±	+	50	—
	QA(BB) 0.2	—	—	—	+	±	+	±	+	25	+	+	+	+	+

* April 16 '52~22 ** April 22 '52~28 † Catalase activity expressed as O₂ tension mmHg evolved from 1.57 cm² of the surface which was exposed to 3% H₂O₂.

が僅かに発生した程度であつた。表面塗布した場合の効果に対し、蒲鉾に練り込んだ場合の効果は Table 2 に示す通りで、2 回行つた試験のいずれの場合も、DHA が最も有効で第 1 回試験では試験期間中全く変化なく、第 2 回試験では無処理の対照が 48 時間後に微生物が多発し、72 時間後のカタラーゼ作用力が 36 mm Hg を示したのに対し、144 時間後によりやくカビが発生し、その時のカタラーゼ作用力は 13 mm Hg にすぎなかつた。次いで DHA-Na, QA(BB) の順に有効であつた。但し、QA(BB) は 30% 純度であるから、0.06% に相当することを考慮すれば、有望な防腐剤と考えられる。これらの防腐剤の効果は蒲鉾の表面に塗布した場合と練り込んだ場合とで異り、表面塗布の場合、全く効果が認められなかつた DHA 及び DHA-Na が練り込んだ場合は顕著な効果を示したことは興味あることである。依つて著者等¹⁾が既に表面塗布した場合について検討した POB, BHC, IAG 及び SA 等の練り込んだ場合の効果及び DHA-Na, DHA と QA(BB) 或は POB との併用効果について検討した。官能検査の結果は Table 3 に示した通りで、POB 及び SA は最も有効で、第 1 回試験では無処理の対照が 72 時間後に微生物が多発したのに対し、POB は 96 時間後に細菌が僅かに発生したにすぎず、その後の微生物の発育は緩慢であつた。第 2 回試験では無処理の対照が 48 時間後に微生物が多発し、72 時間後のカタラーゼ作用力は 36 mm Hg を示したのに対し、POB 及び SA は 72 時間後に細菌が僅かに発生し、72 時間後のカタラーゼ作用力は POB が 4 mm Hg, SA が 6.5 mm Hg であつた。次いで BHC が有効であり、IAG は僅かに効果が認められた。DHA-Na と QA(BB) の併用は第 1 回試験では試験期間中全く変化が認められず、第 2 回試験では 144 時間後によりやく微生物が発生した。DHA-Na 及び QA(BB) をそれぞれ単独使用した場合 (Table 2) の効果と比較すると相乗効果が認められた。しかし DHA と POB の併用は相乗効果を示さなかつた。

Table 3. Effectiveness of several chemicals which were mixed in "Kamaboko" to its shelf life.

Time on incubation at 26°C (hr)		48			72			96			120			144		
Chemicals %	Quality	"Neto"	Fungi	Odor	"Neto"	Fungi	Odor	Catalase activity	"Neto"	Fungi	Odor	Catalase activity	"Neto"	Fungi	Odor	Catalase activity
I	None	—	—	—	+	+	+		++	+	+		++	++	+	
	POB ¹⁾ 0.1	—	—	—	—	—	—		±	—	—		±	±	±	
	BHC ²⁾ 0.1	—	—	—	±	—	—		+	—	+		++	++	+	
	IAG ³⁾ 0.1	—	—	—	—	+	+		—	+	+		±	++	+	
	DHA-Na 0.2	—	—	—	—	—	—		—	—	—		—	—	—	
	QA(BB) 0.2	—	—	—	—	—	—		—	—	—		—	—	—	
II	None	+	±	+	++	+	+	36	++	++	++		++	++	++	
	POB 0.1	—	—	—	±	—	—	4	++	++	+	61				
	DHA 0.2	—	—	—	—	—	—		—	—	—	4	±	±	—	10
	POB 0.1	—	—	—	—	—	—		—	—	—		±	±	—	10
	DHA-Na 0.2	—	—	—	—	—	—		—	—	—		—	—	—	7
	QA(BB) 0.2	—	—	—	—	—	—		—	—	—		—	—	—	7
	SA ⁴⁾ 0.2	—	—	—	±	—	—	6.5	+	+	+		++	++	++	

1) Butyl p-hydroxybenzoate 2) 99% BHC "Lindene" 3) Isoamylgallate 4) O-hydroxybenzamide * April 16 '52~22 ** April 22 '52~28.

Table 4. Effectiveness of combination of the mixing of preservatives and the casing with polyvinyl alcohol. (April 22 '52~27)

Time on incubation at 26°C (hr)			48			72			96			120				
Quality			"Neto"			"Neto"			"Neto"			"Neto"				
Treatment %			Fungi	Odor		Fungi	Odor	Catalase activity	Fungi	Odor	Catalase activity	Fungi	Odor	Catalase activity		
Casing with polyvinyl alcohol	None		+++	+	+	+++	++	+	56	+++	+++	++				
	DHA	0.2	—	—	—	—	—	—	6	±	—	±		±	±	
	DHA-Na	0.2	—	—	—	±	—	±	74	++	—	+		++	—	
	DHA-Na	0.2	—	—	—	—	—	—		++	—	+	200	++	—	
	QA(BB)	0.2														
	QA(BB)	0.2	—	—	—	+	+	—	275	+++	+	+		+++	+	+
	POB	0.1	—	—	—	±	±	—		+++	+	+		+++	+	+
	DHA	0.2	—	—	—	±	—	—		+++	—	+		+++	—	+
	POB	0.1														
SA	0.2	—	—	—	±	—	—	25	+++	—	+		+++	—	+	

2. PVA 包装の場合に於ける各種防腐剤の効果

PVA のアルコール溶液で表面を被覆した場合の効果については既に天野氏等の研究⁹⁾があるが、著者等も各種防腐剤の効果に対するこの被膜の影響について実験した。その結果は Table 4 に示したように、無添加区、添加区いずれの場合にも Table 1, 2 及び 3 に示したそれらに対応する無包装のものに比して鮮度保持効果は却つて減弱している。特に無包装のものに比して細菌が多発したことは、表面の被膜が水和性のために乾燥せず細

菌の発育に適した水分を保持したためかと思われる。この傾向は天野氏等の研究結果と全く一致している。他方、防腐剤として本研究の範囲で最も有効であつた DHA を PVA に 0.5% の割合に溶解し、表面に塗布することにより DHA の表面に於ける効果を狙つた実験の結果は、練り込んだ場合に比し効果が少なかつた。

3. 紫外線、赤外線及びセロファン或は醋酸ビニール包装の効果

著者等は紫外線或は赤外線照射の防腐効果について既に報告した。赤外線は熱線による殺菌効果を示すだけでなく、照射表面の水分の減少にもとづく細菌発育の遅延効果も見逃せない。之に対し紫外線の効果は特に 2,500~2,600 Å の波長が有効なことから考えると、細胞核の変性に原因するのではないかと推察される。かように作用機構の異なる両輻射を併用すれば、防腐効果を一層増大させるのではないかと期待される。

無包装の場合に Table 5 に示したような照射方法をとつてみると、照射方法の如何によつて著しく効果の異なるのが注目される。Table 5, Fig. 1 及び 2 に示す通り、赤外線は最初の 1 回 10 分間（研究方法の項参照）照射しても僅かしか効果を示さないが、毎日 5 分間照射すると、カビの繁殖を有効に抑制することができた。紫外線は毎日 1 回 15 分間（研究方法の項参照）照射するよりも 2 回照射すると更に有効であつた。紫外線の場合に注目されたことは細菌の発育を有効に抑制するが、カビの発育に対しては余り効果がみられなかつた。依つてカビに対し有効な赤外線の適用を組合せてみたところ、試験開始時のみ 1 回赤外線照射することは効果が少なかつたが、隔日に赤外線を 5 分間照射することはカビの発育阻止に極めて有効であり、紫外線の殺菌作用と相俟つて 4 日間の鮮度保持がみられたことは注目すべきである。

次に第二次汚染防止手段としての PVA よりも乾燥性の VAC 塗布或はセロファン包装のものに対し、同様の紫外線、赤外線処理を行つてみた結果は、Table 6, Fig. 1 及び 2

Table 5. Effectiveness of the combination of ultraviolet ray-and infrared ray-irradiation. (May 7 '52~12)

Time on incubation at 26°C (hr)						24	48	72	96	120
Irradiation						"Neto" Fungi Odor	"Neto" Fungi Odor	"Neto" Fungi Odor	"Neto" Fungi Odor	"Neto" Fungi Odor
1st day	2	3	4	5						
—	—	—	—	—	C	± — —	± ++	± +++	± +++	± +++
●	—	—	—	—	1R	— — —	+ ++	++ ++	++ ++	++ ++
●	●	●	●	●	R ₁	— — —	++ — —	++ + ±	++ + +	++ + +
—	○	○	○	○	V ₁	— — —	— — —	+ ++ ±	+ ++ +	+ ++ +
—	◎	◎	◎	◎	V ₂	— — —	— — —	— + ±	— ++ +	— ++ +
●	○	○	○	○	RV	— — —	— — —	— ++ ±	± ++ +	+ ++ +
●	◎	◎	◎	◎	RV ₂	— — —	— — —	— ± —	— ++ ±	— ++ +
●	◎	◎	◎	◎	R ₂ V ₂	— — —	— — —	— — —	± ± —	+ + +

● ; The upper part of "Kamaboko" was irradiated by the infrared ray for 10 minutes once a day at 30 cm distance by a 500-W "Mazda" S-type lump, ○: irradiated for 5 minutes. ○: The entire surface was subjected to a 15-minute irradiation with a 15-W ultraviolet ray lamp at 30cm distance once a day, ◎: irradiated twice a day.

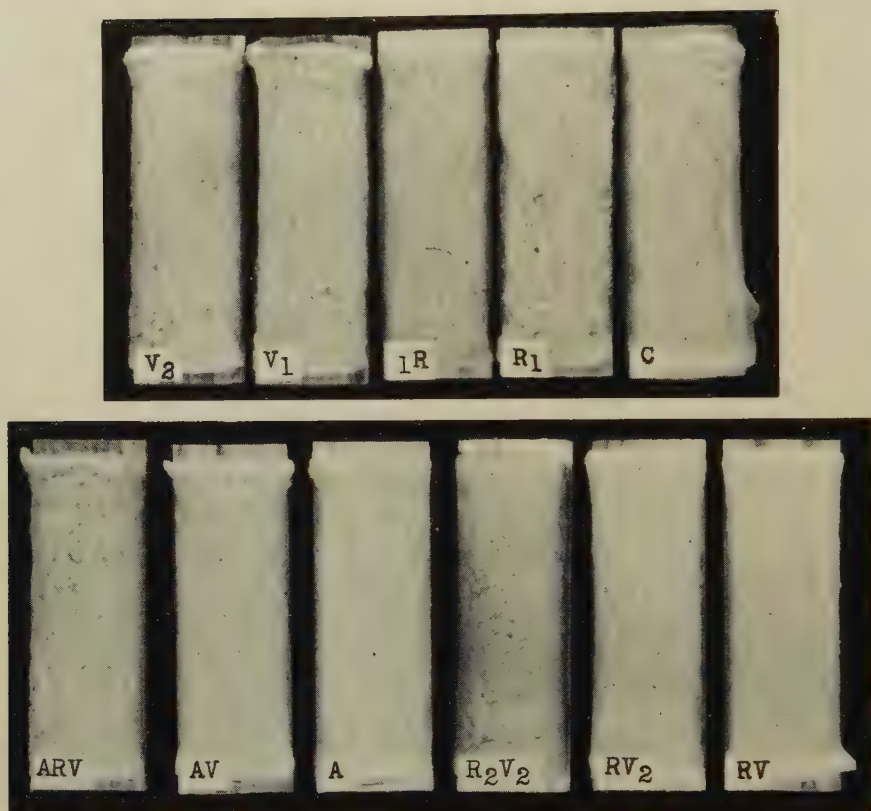


Fig. 1 a. Effectiveness of the combination of casing, ultraviolet ray- and infrared ray-irradiation. After 48 hrs.

C, R₁, ₁R, V₁, V₂, RV, RV₂, R₂V₂. A, AV, ARV: See Tables 5 and 6.

に示したように、赤外線及び紫外線照射の効果は無包装のものより遙かに優秀であつた。しかも二次的汚染が少いため紫外線照射を 1 日に 1 回した場合と 2 回した場合との間には殆ど差がなく、また被覆によりカビの汚染がよく防がれるために赤外線の適用も必要としないようである。被覆手段としては無照射の場合の両方法を比較してみると、セロファンよりも VAC が優つているといえる。また VAC の場合、5 日後に青カビ、黒カビが表面に 2～3 集落をつくつたが、膜の表面であつて内部には殆んど異常はなかつた。

3. 防腐剤、赤外線、紫外線、及び包装を併用した場合の効果

前記の実験からみて最も効果の期待できる防腐剤、即ち DHA 及び POB に対して紫外線照射と包装とを併用した場合に、どの程度の効果があるかを知る目的で次のような実験を行つた。

業者の製造した組成のわかつた肉糊に DHA 或は POB をそれぞれ粉末のまま肉糊の 0.1% 相当量を少量ずつ添加混和した後、成形、蒸煮したものを材料とし、一部は無包装のまま、一部はセロファン包装或は VAC 塗布乾燥後、紫外線のみ或は赤外、紫外面線を照



Fig. 1b. After 72 hrs.

C, ₁R, R₁, V₁, V₂, RV, RV₂, R₂V₂, P, PR, PV, PV₂, PRV, PRV₂,
PR₂V₂, A, AV, ARV: See Tables 5 and 6.

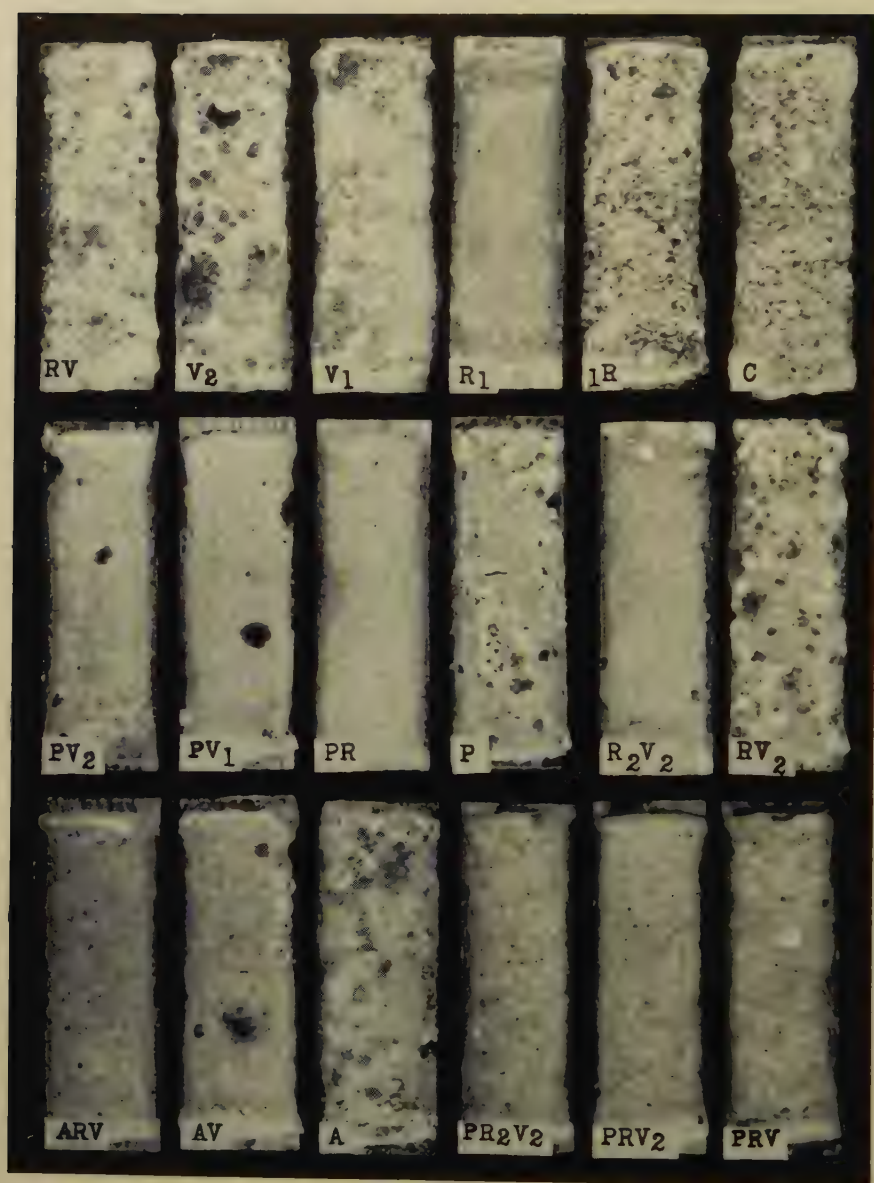


Fig. 1c After 120 hrs.

Table 6. Effectiveness of the combination of casing, ultraviolet ray-and infrared ray-irradiation. (May 7 '52~12)

Time on incubation at 26°C (hr)						24	48	72	96	120	
Casing	Treatment					"Neto" Fungi Odor	"Neto" Fungi Odor	"Neto" Fungi Odor	"Neto" Fungi Odor	"Neto" Fungi Odor	Catalase activity
	1st* day	2	3	4	5						
With cellophane	—	—	—	—	—	—	—	+	+	+	270
	●	●	●	●	●	—	—	+	+	+	
	—	○	○	○	○	—	—	—	—	—	
	—	○	○	○	○	—	—	—	—	—	
	●	○	○	○	○	—	—	—	—	—	
	●	○	○	○	○	—	—	—	—	—	
	●	○	○	○	○	—	—	—	—	—	
With vinyl- acetate	—	—	—	—	—	—	—	—	—	—	38
	—	○	○	○	○	—	—	—	—	—	
	●	○	○	○	○	—	—	—	—	—	
	—	—	—	—	—	—	—	—	—	—	
	—	—	—	—	—	—	—	—	—	—	

* Casing of "Kamaboko" was made after the irradiation with infrared ray, and then was irradiated by infrared or ultraviolet ray.

射した。その後は紫外線のみを毎日1回研究方法の項に示した方法で15分間に亘り全面照射した。26°Cの飽和湿度の下で放置中に於ける官能検査の結果及び10日後の揮発性塩基、揮発酸及び表面のカタラーゼ作用力を求めた値はTable 7及びTable 8に示した。

それらの結果をみると、無処理のものは1日後にカビの繁殖を認めたが、包装して紫外線照射したものは6日後に僅かにカビが繁殖したに過ぎなかつた。他方、DHAを練り込んだものは無包装で5日迄、包装紫外線照射したものは少くとも10日間はカビの繁殖を示さなかつた。POBの場合には無包装で3日迄、包装紫外線照射したものは5~8日迄カビの繁殖がなかつた。但しDHAの場合、10日後には表層肉が多少黄変し僅かに異臭が感ぜられた。10日後に於ける試料の鮮度を化学的に検査した結果、Table 8からわかるように、いずれの判定からみてもDHA-VAC塗布—紫外線照射が最もよく、内部の変敗も全く認められなかつた。セロファン包装のものは肉眼的には同一であつたが、揮発性塩基値が特に多かつた点は説明が困難であつて、今後の研究に俟たねばならない。

IV. 摘 要

1. 無包装の板付無糖蒲鉾を用い、数種の防腐剤を塗布した場合と練り込んだ場合との効果を比較したところ、DHA及びDHA-Naは0.2%の濃度でいずれも蒲鉾の表面に塗布した場合は無効であつたが、練り込んだ場合は鮮度保持に有効であつた。

2. 数種の防腐剤を練り込んだ場合の効果を検討したところ、パラオキシ安息香酸ブチルエステル及びサリチル酸アミドが0.1或は0.2%の濃度で鮮度保持効果が認められた。またDHA或はDHA-Naとパラオキシ安息香酸ブチルエステル或は第四級アミンQA(BB)の相乗効果について検討したところ、殆んど認められなかつた。

Table 7. Effectiveness of the combination of casing, preservatives and ultraviolet ray irradiation to shelf life of "Kamaboko". (May 14 '52-24)

Time on incubation at 26°C (hr)		48	72	96	120	144	168	192	216	240	
Casing & Irradiation	Treatment	Chemicals %		Fungi		Odor		Fungi		Odor	
		"Neto"	Fungi	"Neto"	Fungi	"Neto"	Fungi	"Neto"	Fungi	"Neto"	Fungi
Covered with cellophane and then irradiated by ultraviolet ray.*	None	DHA 0.1	—	—	+	+	+	+	+	+	+
		POB 0.1	—	—	+	+	+	+	+	+	+
Casing with polyvinyl acetate Irradiation byultraviolet ray.*	None	DHA 0.1	—	—	—	—	—	—	—	—	—
		POB 0.1	—	—	—	—	—	—	—	—	—
Casing with polyvinyl acetate Irradiation by infrared and ultraviolet ray.**	None	DHA 0.1	—	—	—	—	—	—	—	—	—
		POB 0.1	—	—	—	—	—	—	—	—	—

* The entire surface of "Kamaboko" was subjected to a 15 minute irradiation with a 15-W ultraviolet ray lamp at 30 cm distance daily after casing. ** The entire surface of "Kamaboko" was subjected to a 10 minute irradiation with a 500-W infrared ray lamp at 30 cm distance only on the 1st day, and after casing was irradiated daily by an ultraviolet ray lamp.

Table 8. Volatile basic-N, volatile acid, catalase activity and organoleptic observations of "Kamaboko" treated with chemical and physical means after 240 hrs. (May 14 '52-24)

Treatment		Volatile basic-N mg%		Volatile acid as CH ₃ COOH mg%		Catalase activity mm Hg		"Neto" Fungi		Odor	
Casing & Irradiation	Chemicals %	Upper part	Inner part	Lower part							
Cellophane Ultraviolet ray	None	—	—	—	28.2	164	—	—	—	—	—
	DHA 0.1	70.7	—	—	—	66	—	—	—	—	—
	POB 0.1	144.1	—	—	—	196	—	—	—	—	—
Polyvinyl acetate Ultraviolet ray	None	21.7	—	21.0	38.5	12	—	—	—	—	—
	DHA 0.1	26.4	22.8	25.3	6.3	6	—	—	—	—	—
	POB 0.1	18.6	—	19.7	44.5	6	—	—	—	—	—
Polyvinyl acetate Ultraviolet ray	None	11.5	—	12.6	38.9	4	—	—	—	—	—
	DHA 0.1	9.4	9.2	9.3	5.7	15	—	—	—	—	—
	POB 0.1	20.7	—	18.0	33.1	58	—	—	—	—	—
Polyvinyl acetate Ultraviolet and infrared ray	POB 0.1	19.7	—	12.5	23.7	8	+	+	+	+	+

3. ポリビニールアルコールで被覆すると無包装よりも悪く、また防腐剤の効果も一般に低下した。

4. 無包装の場合には、短時間の赤外線照射はカビの発育を抑えるが、細菌に対しては効果弱く、逆に紫外線はカビに対して効果が弱い、細菌に対しては極めて有効であつた。また紫外線照射は1日1回よりも2回の方が多少有効であつた。従つて30 cm 距離からの15 W 殺菌灯による15分間全面照射を2回毎日繰り返し、之に隔日に赤外灯(500 W, 30 cm 距離)を5分間照射すると、5日間鮮度が保持された。

5. セロファン或は醋酸ビニールで全面を覆うと、カビの二次的汚染が少いたためか、赤外線照射の効果は認められなかつたが、紫外線照射は有効であつた。この場合には1日に1回照射した時と2回照射した時との間に殆んど差がなかつた。

6. DHA を1/1,000 練り込み、セロファン或は醋酸ビニールで被覆し、紫外線を毎日1回15分間全面照射すると、少くとも26°C で10日間鮮度が保持された。

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Résumé

In the previous papers¹⁾²⁾, it was reported that the casing with cellophane, the irradiation by infrared and/or ultraviolet ray showed a marked prolongation of shelf-life of "Kamaboko". It was further noticed that when the preservatives were smeared on the surface, the combination of the preservatives and casing was rather inferior to the control group without casing. However, when the preservatives were mixed with the paste, the combination did not show any inferior effect to the control.

The present paper deals with a comparison of the effectiveness between preservatives which were mixed with the paste and those which were applied on the surface, and further with the effectiveness of casing with cellophane, polyvinyl alcohol and polyvinyl acetate film and of infrared and/or ultraviolet ray irradiation all over the surface of "Kamaboko".

1. When the preservatives were mixed with the paste, dehydroacetic acid and its sodium salt were effective in prolonging the storage life to six and four days, respectively, in contrast to two days in the control at 26°C. However, the preservatives which were smeared on the surface were not effective (See Tables 1 and 2).

2. Among the preservatives which were mixed with the "Kamaboko", butyl p-hydroxybenzoate and o-hydroxybenzamide showed effectiveness to some extent on keeping quality (See Table 3).

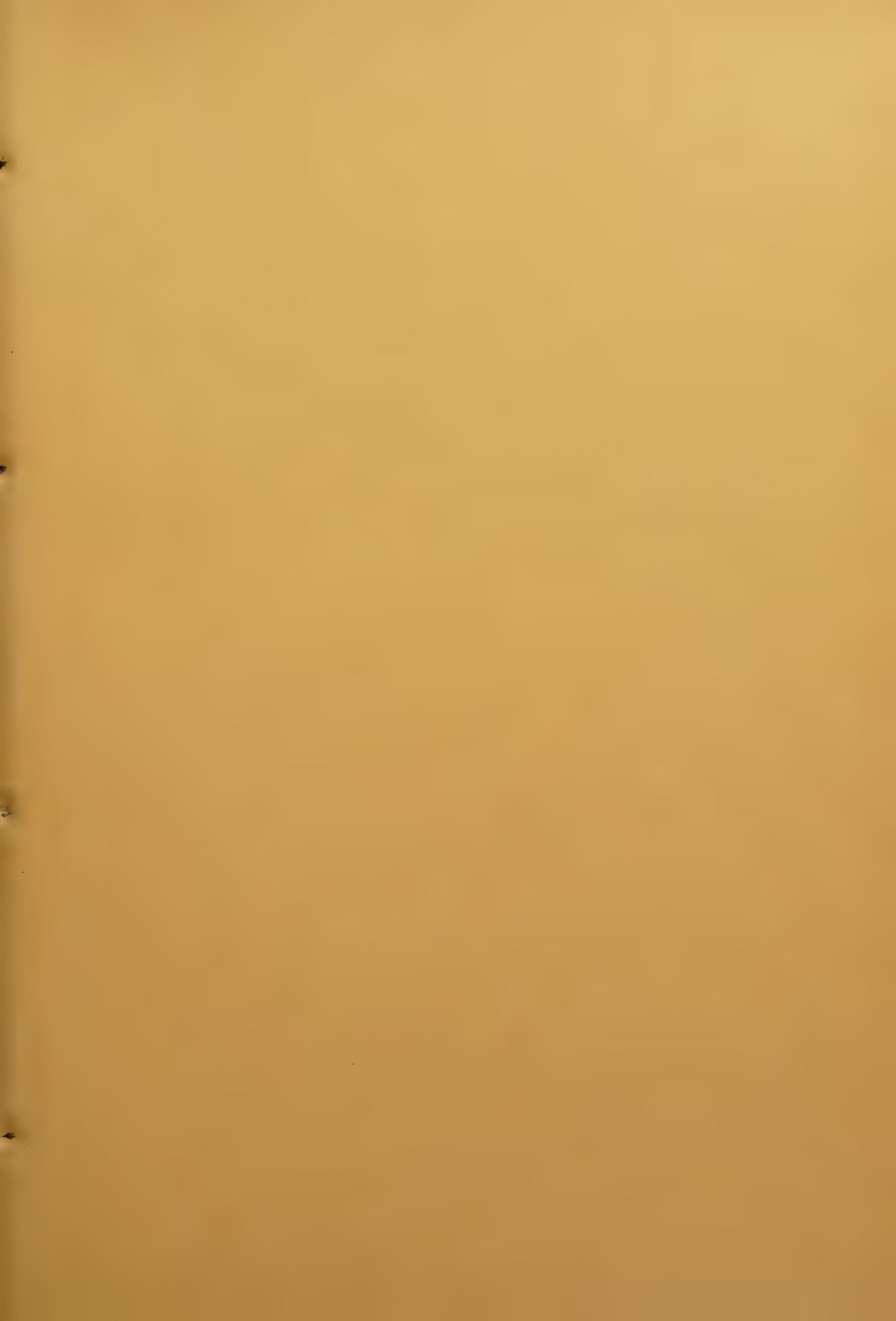
3. The casing with polyvinyl alcohol film gave rather an inferior result. The combination of the casing with polyvinyl alcohol film and the mixing with preservatives shortened the shelf-life compared to the control (See Table 4).

4. In the case of "Kamaboko" without the casing, irradiation by the infrared ray for short time prevented the growth of bacteria. However, irradiation by ultraviolet ray showed remarkable effect on inhibition of bacterial growth. Irradiation by ultraviolet ray twice daily was slightly more effective than that once daily. The combination of irradiation by ultraviolet ray twice daily and that by infrared ray every other day was effective in prolonging the storage life to five days in contrast to two days in the control without the irradiation (See Table 5, Figs. 1a, 1b and 1c).

5. Irradiation by ultraviolet ray over "Kamaboko" which was covered with cellophane or polyvinyl acetate was also effective. No difference was observed between the irradiation once daily and twice daily (See Table 6, Figs. 1a, 1b and 1c).

6. Daily irradiation by ultraviolet ray all over the surface of "Kamaboko" which contained DHA at a 0.1 % level and covered with cellophane or polyvinyl acetate was able to prolong the storage life to 10 days in contrast to a storage life of two days in the control at 26°C (See Tables 7 and 8).

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魚体或は魚肉内へのオーレオマイシンの浸透
及びその加熱破壊速度*

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Penetration of Chlortetracycline into Fish Flesh or Round Fish and its Heat Inactivation

Tetuo TOMIYAMA, Yasuo YONE, and Kazuo MIKAJIRI

TOMIYAMA *et al*⁵⁾ reported that a dip in CTC-solution and/or a storage in CTC-ice were markedly effective to keep freshness of round fish. Only limited data, however, are available which show distribution pattern of CTC in the treated fish and the rate of heat inactivation of CTC in the flesh at varying temperatures. The objective of this paper is to answer these questions which are of importance from standpoint of fishery technology as well as public health. The following results are obtained by employing a modified pad-plate method for the determination of CTC.

1. Except for pilchard and a small mackerel no penetration of CTC occurred into the flesh of several species of round fish after a 27-hour storage in chilled sea water containing 100 p.p.m. of citric acid and 10 p.p.m. of CTC.

2. After a 27-hour storage of "ISAKI" in the CTC-sea water no CTC was found in the flesh or the viscera while it was found in both skin and gills.

3. When bonito fillet was immersed in the CTC-sea water, it was found that CTC readily penetrated into the flesh.

4. The rate of heat inactivation of CTC which was included in bonito flesh increased remarkably with the rise of temperature. A linear relationship was obtained between the residual CTC (%) the logarithm of the time of heating.

I 緒 言

魚類の鮮度保持に対してオーレオマイシン (化学名 chlortetracycline, 以下 CTC と略記) が極めて有効であることは最近かなり多数の研究によつて立証されている。フィレー及び内臓抜きの魚体については TARR 及び共同研究者¹⁾²⁾, FARBER³⁾, FIRMAN 及び共同研究者等⁴⁾の研究があり, 魚体のまゝ (round fish) のものについては富山及び共同研究者⁵⁾の報告がある。

しかし, もしも CTC 処理によつて多量の CTC が魚体内に浸透するならば, 日常魚類の摂取と共に CTC を食下することになるので, 腸内細菌の型及び数の変化, 病原菌の CTC 耐性等の問題が食品衛生の見地から提起される。従つて round fish 或は魚肉を CTC 処理した場合の魚体内或は魚肉内への CTC の浸透量及び加熱による魚肉中の CTC の破壊速度に関する正確な知識をえることは水産業の立場から必要であるだけでなく, 食品衛生の点からみて極めて重要なことである。

この問題を解決するためには, 適当な CTC の微量定量法が必要である。著者等は最近 KOHLER 及び ABBEY⁶⁾の提出している pad-plate 法が本研究に適しているかを吟味した結果, 入手し難い培地の成分及び標準曲線の求め方について多少変改を試みて満足すべき結果をえた。夫故に本報告においてはこの方法を利用して, (1) 数種の round fish 或は魚肉を CTC-海水に浸漬した場合の CTC の浸入量, (2) CTC-海水に浸漬した round fish 内における CTC の分布, (3) CTC を吸収した魚肉の

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よる破壊速度に関する研究を行つた。

II 実験の部

1. 魚肉中の CTC の定量法

CTC の定量法としては、比色法⁶⁾、カップ法⁶⁾、比濁法⁶⁾、重層法⁷⁾、pad-plate 法⁸⁾⁹⁾等がある。しかしこのうち pad-plate 法以外は魚肉組織中の微量 CTC の定量には用い難い。最近 KOHLER 及び ABBEY⁹⁾ は pad-plate 法による筋肉中の CTC 定量法に *Bac. cereus* No. 5 の胞子を用いる方法を提出している。

依つて著者等はこの方法につき予備試験した結果、培地の成分が入手し難かつたこと及び標準曲線の作成に不備の点があることを認めたので、原法を多少変改した。

a. 培地の組成と inoculum の調製： KOHLER 及び ABBEY は GRADY 及び WILLIAMS⁸⁾ の培地を inoculum の培地に用い、検定用には Difco brain heart infusion を用いている。これらの培地成分のうち trypticase-soybroth (BBL), beef extract 及び Difco brain heart infusion は入手できなかつたので、著者等が調製したカゼインの酸分解物及びカツオ肝自己消化物で代用した。その組成は Table 1 に示す通りである。なお GRADY 及び WILLIAMS⁸⁾ は base layer を使用せずに seed layer のみを薄くした場合に感度がよくなると報告しているので、著者等も seed layer のみの培地を使用した。

Table 1. Culture medium for assay

Peptone	3.0 g
Dry yeast	1.5 g
Liver extract*	0.75 g
Glucose	0.5 g
Casein hydrolysate by acid**	20 cc
Agar	5.0 g
Water	480 cc

* A solubilized bonito liver prepared by TOMIYAMA's method.

** Equivalent to 2 g of casein.

inoculum は次のようにして調製した。培地 300 cc を 121°C で 10 分間 高圧加熱殺菌し、これに *Bac. cereus* No. 5 を接種し、37°C で 4 日間振盪培養する。なお培養 48 時間及び 72 時間後に培地 1cc 当り Mn^{++} として合計 5r になるように第一硫酸マンガンの稀溶液を加える。この培養法によつて大部分の細胞は孢子化しているので、これを遠心して上澄液を除き、殺菌した 3% 食塩水で 3 回洗滌後、遠心して胞子を 30cc に懸濁する。この懸濁液を 70°C で 30 分間加熱した後、冷蔵庫に保管する。なおこの胞子懸濁液の最適使用量は予備試験の結果によると、培地 100cc 当り 2cc であつた。

b. 魚肉からの抽出： 供試魚肉 20g に CTC 抽出液（アセトン 65 部、水 30 部及び 4N 塩酸 5 部）100cc を加え、ミキサーでよく混合細切した後、CTC 抽出液で原容量に充す。これを遠心して上澄液を分ち、10N 苛性ソーダで pH 4.2 に調製した後に CTC の生物検定にかける。

c. 標準曲線： 原法⁸⁾⁹⁾では組織抽出液に既知量の CTC を添加して標準曲線をつくるように指示してある。しかし著者等が魚肉に既知量の CTC を添加して抽出し、回収率を原法の標準曲線を用いて検討した結果では、 $85 \pm 2\%$ であつた。従つて原法に記載の標準曲線は魚肉の場合には不適当と思われるので次のように変改した。

魚肉粥 20g に 200r の CTC を添加しよく混合した後、前記抽出剤 100cc を加えて前項記載の方法で抽出、定容、遠心し、遠心液の pH を 4.2 に調整する。他方 CTC を添加しない魚肉を同様に抽出剤で処理した抽出液で前記の CTC を含む原抽出液を 2 倍づつ順次に希釈して 2r/cc から 0.062r/cc までの濃度のものをつくる。この各濃度のものを pad-plate に吸収させ、次に示す検定操作に従い *Bac. cereus* の発育阻害帯の直径を測定する。その値を相当する濃度の対数値に對し図示し、標準曲線をつくる。

d. Assay の操作： Table 1 に示した組成の培養液 25cc を 121°C で 10 分間 高圧加熱滅菌し、60°C に放冷した後、*Bac. cereus* No. 5 の胞子懸濁液を混和し、次に平坦な底をもつ径 7 吋のペトリ皿に流し込み、定量用の seed layer をつくる。他方、径 1/4 インチの paper-pad (Carl Schleicher & Schull, 740 E) を前記の抽出液に浸漬し、余分の液を除いた後にペトリ皿の seed layer 上に並べる。ペトリ皿は 4°C に 1—2 時間放置後に 27°C の恒温器に入れて 12 時間培養する。paper-pad の周囲にできた阻害帯の直径を測定し、標準曲線と比較して CTC の濃度を求める。

2. 研究材料及び CTC による処理方法

使用した CTC 製剤は純度 89% のものであり、日本レダリー会社より供給された。実験に用いた魚類はイサキを除いてはみな市場より入手したもので、づいれも良好の鮮度を保つていた。

CTC の浸漬処理には多くの場合 100 ppm のクエン酸を含む海水に、CTC として 10 ppm を含むように CTC 製剤を溶解したもの (CTC—海水と略記) を 4°C に冷却して使用した。この海水の pH は 5.2 を示した。

a. Round fish への CTC の浸透速度の測定：この実験にはイワシ (*Sardinia melanosticta*), サバ (*Scomber japonicus*), アジ (*Trachurus japonicus*) 及びタイ (*Pagrosomus major*) の 4 種を用いた。魚体は 4°C の CTC 海水 1 L に対し 200 g の割合で浸漬し、30 時間毎に CTC 海水をとりかえた。一定時間後に供試魚を取り出し、鱗を除き、洗滌後に皮のついたまま適当に切断し、CTC の定量を行った。

b. CTC の魚体内の分布：漁船より直接生きたイサキ (*Paropristipoma trilineatum*) を求め、死後強直前のものを用いた。これを 4°C の CTC—海水中に浸漬し、一定時間後、外部を少量の水で洗い、次にエラ、皮、肉等を切りとり、これらの CTC を定量した。

c. 多量の魚体を浸漬した場合の海水中の CTC の減少：4°C に冷却した 160 cc の CTC 海水に 2 尾のアジ (約 160 g) を 30 分間浸漬し、これを取り出して後、同量のアジの 30 分間浸漬を更に 3 回実施した。なおこの場合の標準曲線の CTC レベルは 20 r/cc から 1.25 r/cc までの濃度とし、各回浸漬液は稀釈せずそのまま測定し、各液共 3 つの測定値の平均をとった。

d. 魚肉中への CTC の浸透：5 cm 角に切りとつたカツオ肉の数枚を 4°C に冷却した CTC—海水 1 L に浸漬し、1 時間後及び 5 時間後に適量取り出し軽く洗滌した後、この肉の表層 10 mm 迄の肉層と 10 mm より 20 mm 迄の肉層とを切りとり、それぞれの部分の CTC を定量した。

e. 肉に含まれる CTC の熱による破壊：大きさ 1.3 cm 角、重さ 3.0—3.4 g のカツオ肉を、4°C に冷却した CTC の 50 ppm を含む水溶液に 3 時間浸漬し、充分に CTC を浸透させた。この肉塊は軽く洗滌後、一部の肉塊について CTC を定量したところ、21.0 ppm を含むことを知った。他方、予め一定温 (55°, 76° 及び 93°C) に保つた 10 cc の水を入れた大型試験管に上記の肉塊を 3 ケづつそれぞれ加え、試験管内容は肉が砕けないように注意しつつ攪拌器で徐々に混和し、一定温度に保つた。一定時間後に試験管を流水で冷却し、内容は全部ミキサーで均一化し、CTC の定量に供した。

III 研究結果及び考察

1. Round fish 中への CTC の浸透

実験の部に記載した方法で数種の round fish を 4°C の CTC—海水 (10 ppm) 中に浸漬した場合の CTC の浸透速度を測定した。その結果は Table 2 に示してある。この表にみられるようにイワシ及び小型のサバを除いては浸漬 27 時間後においても定量法の精度の範囲では CTC は鱗を取り除いた可食部中に全

Table 2. Penetration of CTC into round fish dipped in sea water containing 10 µg/cc of CTC

Kinds of fish (Body length)	Hours of dip at 4°C					
	0	2	6	27	50	70
Pilchard* (7 cm)	0	1	1	4	—	—
Pilchard (13 cm)	0	1	1.6	2.7	2.8	—
Common mackerel** (14 cm)	0	1	1.5	2.1	—	—
Common mackerel (25 cm)	0	0	0	0	—	—
Horse mackerel† (19 cm)	0	0	0	0	—	2.8
Horse mackerel (24 cm)	0	0	0	—	—	—
Red sea bream§ (8 cm)	0	0	0	0	0	—

* *Sardinia melanosticta*.

** *Scomber japonicus*.

† *Trachurus japonicus*.

§ *Pagrosomus major*.

く見出されなかつた。イワシ及び小型のサバの鱗を取り除いた可食部内への浸透は恐らく表皮が薄いこと、鱗で充分に蓋われていないことまた定量用試料中に表皮量が比較的多かつたことなどに原因すると推察される。

Table 3. Penetration of CTC into various parts of "Isaki", *Parapristipoma trilineatum* dipped in sea water containing 10 µg/cc of CTC

Tissue	Hours of dip at 4°C			
	0	2	6	27
Flesh	0	0	0	0
Viscera	0	0	0	0
Skin	0	1.0	1.0	1.0
Gill	0	1.0	1.0	1.0

な実験からも裏づけされる。4°C の CTC—海水に同量のアジを 30 分間順次に 4 回浸漬した場合、各浸漬後の CTC 濃度は最初 10.0 のものが 10.1, 10.1, 10.0 及び 9.8 の値を示した。即ち実験誤差の範囲内では殆んど減少がみられなかつた。もし魚体が 1 ppm の CTC を吸収したとすれば、一回の浸漬で CTC 濃度は 10% 減少し、各回の濃度は 9.0, 8.0, 7.0 及び 6.0 ppm 減少すべきである。しかし CTC の浸入する部位が表皮及び鰓であるから、もしこの部位が魚体の 5% を占めると仮定し、更にこれらの部分での CTC の浸透量が 1 ppm と仮定すれば、浸漬各回の濃度は 9.95, 9.90, 9.85 及び 9.80 と減少すべきであつて、上記実験値と近似している。この推定計算からわかるように round fish による CTC の吸収量は極めて少いことが理解できる。またこの結果は魚体の鮮度保持に要する CTC の量が如何に少量でよいかを示唆するものである。しかし実際の問題としては浸漬を続けることにより CTC—海水は甚しく汚染するので、CTC の減少量は少いに拘らず取換える必要がある。

STEINER 及び TARR¹⁰⁾ は内臓抜ききの gray cod を CTC 氷で氷蔵した場合には CTC の浸入は極めて少量で、しかも主として腹腔内と皮の部に起ることを認めた。また冷却した CTC—海水に貯蔵した場合に比し CTC 氷による貯蔵の場合には CTC の浸入量が少いと報じている。最近、著者等¹¹⁾は内臓抜ききのキハダマグロ (*Neothunnus macropterus*) を漁獲後直ちに 5 ppm の CTC 氷で氷蔵し、60 日後魚体各部の含量を測定したところ、腹部肉と表皮に 0.2—0.5 ppm の CTC が認められたが、他の部分の肉中には全く認められなかつた。

本研究の結果並に STEINER 及び TARR の結果は CTC 処理による魚体の鮮度保持のメカニズムに対し重要な示唆を与えと共に食品衛生上の重要な資料を提供するものといえる。即ち round fish の CTC 処理は魚体表面の細菌の発育を抑制し、魚肉内への細菌の浸入を遅らせることにより鮮度保持の効果をあらわすもので、既に筋肉内に浸入した細菌の発育抑制には効果が期待できないといえる。このことから富山等^{5c)}が報告したように、漁獲直後で細菌が筋肉内に浸入していない新鮮な魚体を速に CTC 処理することによって最大の効果が収められることも理解できる。本研究並に STEINER 及び TARR¹⁰⁾の研究の結果から判断すると、CTC 氷を round fish の鮮度保持に使用することは、CTC が筋肉に殆んど浸透しないので、食品衛生上最も安全な鮮度保持方法といえる。

本研究によつて小型魚類を除いては CTC 処理した round fish の筋肉内へは CTC が殆ど浸透しないことが明かになつたので、この処理魚を生食したとしても日常 CTC を食下する懸念はないといえる。わが国ではマグロ類のような大型魚の二三を除いては魚類は round のままで消費に向けられるので、この点一層安全である。また一般に魚類は加熱処理して摂取することが多いので、CTC の加熱破壊速度の項にみられるように、CTC の大部分は破壊するので CTC を食下することは全くないといえるであろう。

2. CTC の魚肉内への浸透及び浸透 CTC の熱による破壊

CTC—海水に浸漬したカツオ筋肉へ CTC がどの程度浸透するかを測定した結果は Table 4 に示してある。この表から明らかなように round fish の場合と異り、CTC は比較的容易に筋肉内に浸透し、5 時間の浸漬で表面より 2 cm の層迄浸入した。しかし CTC の浸透速度が遅いことから考えると、筋肉の深部に浸

次に新鮮なイサキを 4°C の CTC—海水中に浸漬した場合の体各部における CTC の分布を検討した。その結果は Table 3 に示してある。この場合、浸漬後 2 時間には既に表皮及び鰓に CTC が浸入していたにもかかわらず、筋肉及び内臓中には浸漬 27 時間後でさえも CTC は浸入しなかつた。またアジを同様に 4°C の CTC—海水中に浸漬 6 時間後、表皮下 5mm 厚さの筋肉層内への浸入を検したところ、CTC は定量法の精度の範囲内において全く検出されなかつた。

round fish が CTC を吸収し難いことは次の間接的

入した細菌の発育を CTC の浸漬処理のみで抑制することは極めて困難であろう。

鮮肉を CTC—海水に浸漬した場合の CTC の浸入が内臓抜きの場合より速かなことは FIRMAN 等⁴⁾ の結果からも明かである。即ち同一魚種ではないが、scrod の生肉を CTC—海水に 10 分間浸漬すると、CTC の浸透量は内臓抜きの butter fish を同様に処理した場合より遙かに大であることが示されている。

Table 4. Penetration of CTC into block of bonito flesh (5×5×5cm) held in sea water containing 10 µg/cc of CTC at 4°C

Hours dipped	1	5
Outer parts (0—10mm)	1.2	2.4
Inner parts (10—20mm)	0	1.0

筋肉内に浸透した CTC の耐熱性については、TARR 及び共同研究者²⁾は磨砕した ling cod 或は coho salmon の肉に 5γ/g の CTC を加え、これを 100°C に 30 分加熱した場合、その 10% が残存していたと報告している。また最近 STEINER および TARR¹⁰⁾ は一般の料理条件 (内部温度 82—99°C) では添加した CTC の 80—90% は破壊できるであろうと推定している。しかし筋肉中の CTC が各種温度においてどの程度の速度で破壊するかについては研究がなされていない。依て 21 ppm に達する多量の CTC を吸収したカツオの筋肉を用いて 55°, 76° 及び 93°C における熱破壊速度をみた。その結果は Table 5 に示す通りである。この実験では肉の内部温度の測定を行なかつたので、所定の温度にまだ達していない短時間内の破壊率は近似値に過ぎないと思われる。

Table 5. Residual amount of CTC in bonito flesh after heating at varying temperatures

Time of heating (min)	Temperature of heating (C)					
	55		76		93	
	p.p.m.	%	p.p.m.	%	p.p.m.	%
0	21.0		21.0		21.0	
5	16.0	76.2	14.0	66.7	13.0	61.9
10	15.0	71.4	10.7	53.5	8.7	41.4
30	11.0	52.4	4.0	19.0	1.6	7.61
6	10.0	50.0	0.0	0	0.0	0

筋肉内の残存 CTC 濃度 (%) を加熱時間 (分) の常用対数値に対し図示すると、誤差の範囲内で Fig. 1 に示すように各温度に固有の直線関係がえられる。この実験では実験数も少く且内部温度の測定も欠いであるので、この直線から CTC の熱破壊の温度係数を求めることは困難である。しかしこの図から近似的には、肉中の CTC が 10% となる為には 93°C で 26 分、76°C で 45 分を要することが求められる。一般の料理或いは食品加工の条件では CTC を多く含む表皮及び肉の外層は中心部より早く所定の加熱温度に達するので、この場合の破壊速度は本研究でえた破壊速度よりも多少速かであろう。

鮮度保持のための CTC 処理では、鮮度保持効果が CTC 濃度に比例しないこと^{5a)} 及び CTC の価格の点

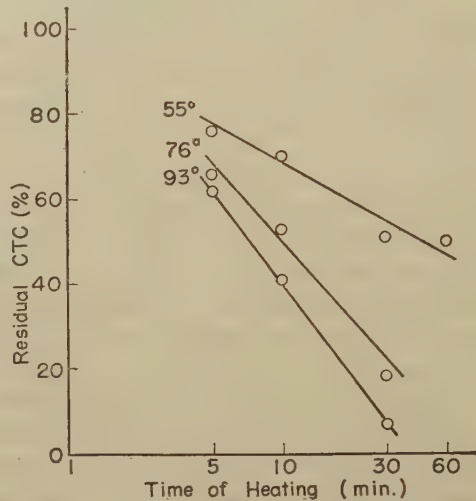


Fig. 1 Relationship between residual CTC and time of heating at varying temperatures.

から考えて、恐らく 10 ppm 以上を使用することは稀であろう。従つて 10 ppm の CTC で処理した鮮肉を一日 100 g (肉蛋白として約 20 g) 生食したとすれば、Table 4 に示した結果から推定すると最大 0.2 mg の CTC (全食糧乾物当り約 0.3 ppm) を食下することとなる。しかしこれを 10—20 分間煮沸処理して摂取すれば一日 100 g をとつても CTC の食下量は 0.02—0.04 mg 程度に過ぎないであろう。最も極端な場合即ち 0.2 mg CTC を食下した場合に腸内細菌叢がどれだけ変化するかについては勿論実験的研究が必要である。しかし米国において数年間実用している CTC 含有飼料 (飼料乾物当り 20 ppm CTC) から家畜が CTC を食下している量は遙かに多量である。この比較的多量の CTC の食下が家畜の生長を促進することは疑いのない事実であるが、その作用機構についてはまだ完全に解決されていない。しかしこの機構の一つとして腸内細菌叢の改善があげられている。夫故に家畜の場合の添加濃度の約 1/70 以下の CTC の濃度では腸内細菌叢の改善は恐らくみられないであろう。

IV 総 括

著者等の変改した Pad-plate 法を用いて、数種の round fish 或は魚肉を CTC 液に浸漬処理した場合における CTC の魚体内への分布或は筋肉への浸透量を定量し、更に筋肉内の CTC の熱破壊速度を各種の温度で測定した結果は次のように要約できる。

1. round fish を CTC—海水 (10 ppm) に 27 時間浸漬した場合に、イワシ及び小型サバを除いては筋肉中に CTC は検出できなかった。
2. 新鮮なイサキを CTC—海水 (10 ppm) に浸漬した場合には鰓及び表皮に比較的速かに浸透したが、筋肉及び内臓には浸透しなかった。
3. カツオ筋肉を CTC—海水 (10 ppm) に浸漬した場合には比較的速かに CTC は浸透した。
4. カツオ筋肉に浸透した CTC の熱破壊は温度の上昇と共に著明であつた。各温度における CTC の残存量 (%) は加熱時間の指数函数で示された。

終りに CTC の定量法の検討に助力された農学士津田厚氏に、また CTC の試料を提供れた武田薬品工業 KK 及び日本レタリー KK に謝意を表する。

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緒 言

魚の防腐に関する従来の研究では、既知の或は新発見の防腐剤を用い、切身または摺身を材料として行われたものが多い。併し丸のままの魚体の防腐を考えた場合、体表面粘質物、血液、胆汁その他の諸成分が防腐剤に影響を与える可能性が考えられる。

Fellers¹⁾は鮭の体表面の粘質物を集めて殺菌し、細菌の培地に供した処、細菌の増殖が非常に良好であつたと述べており、一方 Stewart²⁾, Aschehoug & Vesterhsu³⁾, Shewan⁴⁾は鱒、鯉の体表面粘質物から *Achromobacter*, *Micrococcus*, *Flavobacterium* 等の細菌を分離したことを報告している。これらの報告に照してみても分るように、魚体表面の粘質物が細菌発育の基質として魚の腐敗に何等かの役割を演じているであらうことは容易に想像される。著者等は防腐剤を使用して丸のままの魚体を保蔵する場合、魚体表面の粘質物が防腐剤に対して何等かの影響を及ぼすのではないかと考え、ブイオンに粘質物を添加した培地で防腐剤の効力を検討し、若干の結果を得たのでここに報告する。

I. 実 験 方 法

魚体粘質物としては四季を通じて入手し易い鱈粘質物を用いた。鱈を 94 % アルコール中に投入すると体表面の粘質物は白く凝固するので、これをこさぎとり、アルコールで数回洗滌後、アルコールをとばして乾燥、粉碎した粗製粉末を材料とした。収量 0.4~0.5 %。この粉末は水には殆んど溶けないが、うすいアルカリには徐々に溶けて強い粘性を示すので、0.5 % 苛性ソーダを用い 1 % の濃度になる様に粉末粘質物を加え約 15 時間 30°C の孵卵器内に放置後、稀塩酸で pH 7.0 に調整、吸引濾過して微橙色の透明な濾液を得、実験に供した。このものは 120°C、20 分間加熱すると透明度がややおちる。*

前記の粘質物溶液を 4 c.c. の 2.5 倍強ブイオン(肉エキス 10g, ペプトン 10g, 食塩 2.5g, 水 400 c.c.) に加え、殺菌水道水で総量を 10 c.c. となし、ブイオン濃度が夫々一定になるよ

* 混濁の程度は僅少で、光電計を用いる本実験に支障はない。

うにした。この際殺菌操作 (120°C 20 分間) はブイヨンに粘質物溶液を加える前に夫々別個に行い、混合後の加熱操作は避けた。従つて混合操作は無菌的に行つた。

供試菌としてはブイヨンに 24 時間培養を継続した *Escherichia coli* 及び *Pseudomonas fluorescens* 33 F* を用い、透過率が 85~90 % になる様に稀釈した菌液 0.2 c.c. を供試培地に接種し、30°C における菌の増殖を光電計で追跡した。

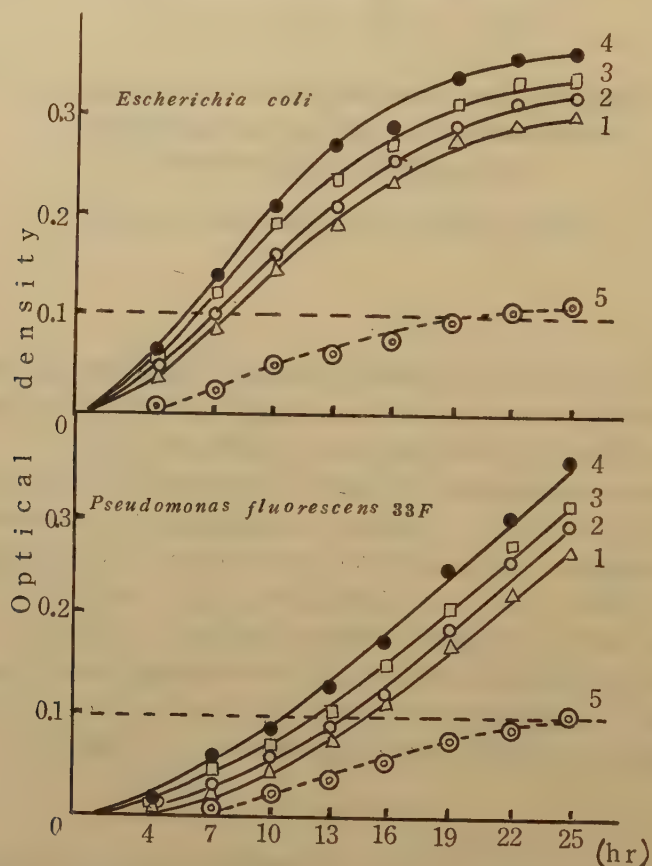


Fig. 1. The effect of mucus of Japanese loach on the growth of *Escherichia coli* and *Pseudomonas fluorescens* 33 F.

- (1) Bouillon
- (2) Bouillon + 1 c.c. mucus soln.
- (3) Bouillon + 3 c.c. mucus soln.
- (4) Bouillon + 5 c.c. mucus soln.
- (5) Mucus soln.

* 所蔵の *Pseudomonas* はすべてブイヨン培地で皮膜を形成するが、本菌株は皮膜を形成しないので、吸光度によつて菌の増殖度を測定するのに都合がよい。
本菌株を下さつた故長尾清北大教授に謝意を表する。

II. 実験結果及び考察

(1) 細菌の増殖に及ぼす鰻粘質物の影響

鰻粘質物が細菌の増殖にいかなる影響を与えるかを見る為に、2.5倍強 ブイヨン 4 c.c. に粘質物溶液を 1 c.c., 3 c.c., 5 c.c. 加え殺菌水道水で総量を 10 c.c. とし細菌の増殖を追求した。結果は Fig. 1 に示した。

ブイヨン培地に粘質物を添加すると、添加量の増加に従つて細菌の増殖は促進される傾向を示すが、粘質物のみでは増殖が甚だ悪く、培地として良好なものとは云い難い。

この粘質物溶液の全窒素含量は 0.1008 % である。細菌培地としての窒素の必要量は 0.1 ~ 0.5 % と云われているので、細菌に利用されない窒素化合物が含まれているのか或は炭素源、growth factor その他の成分が不足なのであらう。

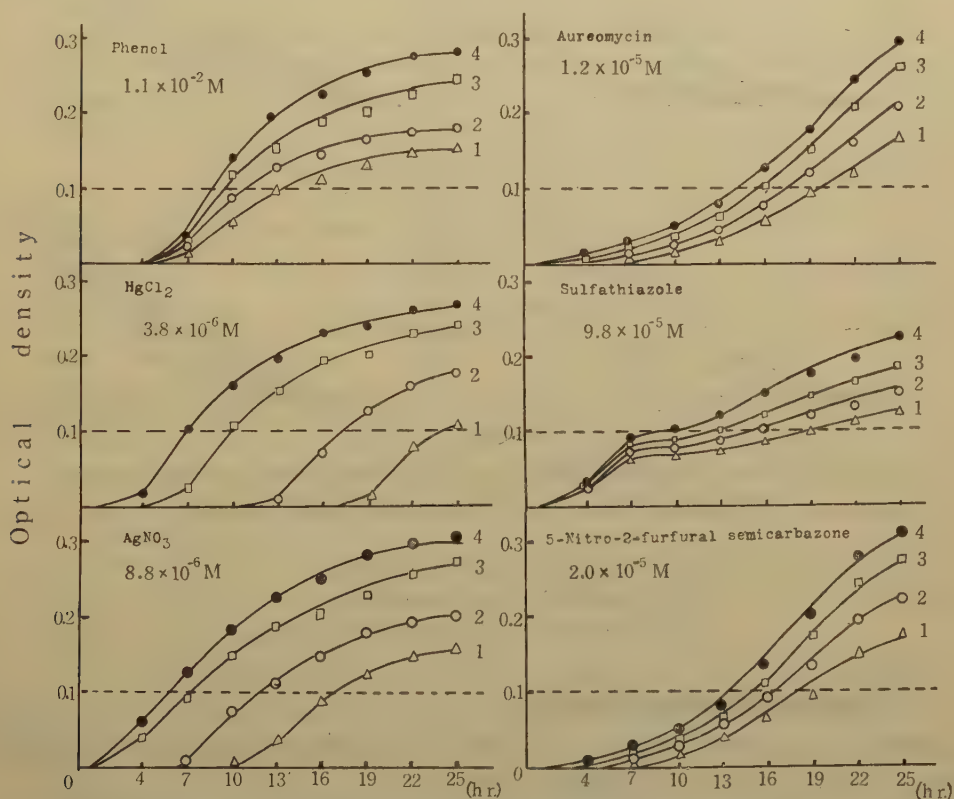


Fig. 2. The effect of mucus of Japanese loach on the growth of *Escherichia coli* in the presence of various preservatives.

- (1) Bouillon
- (2) Bouillon + 1 c.c. mucus soln.
- (3) Bouillon + 3 c.c. mucus soln.
- (4) Bouillon + 5 c.c. mucus soln.

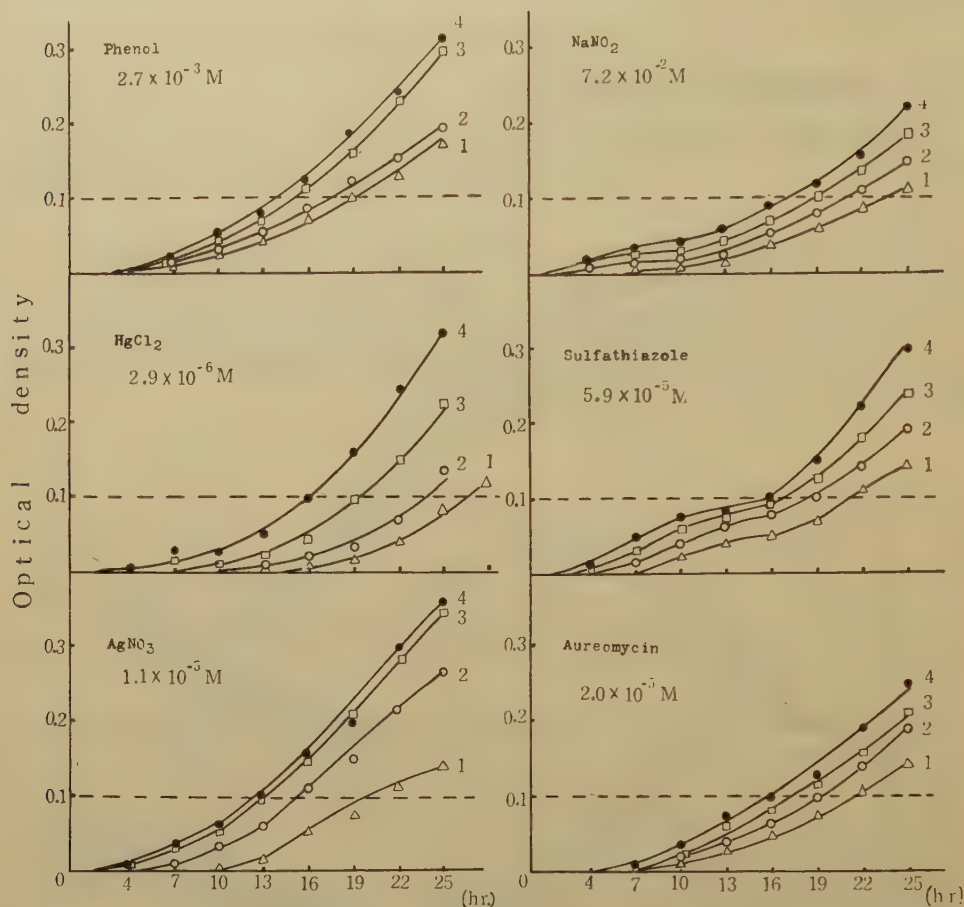


Fig. 3. The effect of mucus of Japanese loach on the growth of *Pseudomonas fluorescens* 33F in the presence of various preservatives.

- (1) Bouillon
- (2) Bouillon + 1 c.c. mucus soln.
- (3) Bouillon + 3 c.c. mucus soln.
- (4) Bouillon + 5 c.c. mucus soln.

(2) 鰯粘質物と防腐剤との拮抗作用

防腐剤としては Sulfathiazole, Aureomycin, 亜硝酸ソーダ, 5-Nitro-2-furfural semicarbazone, 石炭酸, 昇汞, 硝酸銀の7種を用いた。

ブイヨン培地で24時間後の細菌の増殖が吸光度 0.1~0.15 を示す防腐剤濃度を予備実験で求め、この濃度において鰯粘質物の防腐剤に及ぼす影響を検討した。Fig. 2, 3 にその結果を示した。

この結果から考察すると、粘質物の増加にともなつて菌の増殖はよくなつていたので、粘質物は防腐剤と拮抗的に作用すると考えられる。

Fig. 1 に示した如く粘質物は菌の増殖を促進するので、Fig. 2, 3 の現象は粘質物の増殖促進作用以外の作用によつても起るか否かを確かめるために、粘質物の存在の下における防腐剤の阻害度を求めて検討を行つた。

興津等²⁾は防腐剤を加えない培地における菌の増殖が吸光度 0.1 に達する時間を T_0 、防腐剤を加えた培地における菌の増殖が同じ値に達する時間を T として防腐剤の阻害度 H を

$$H = 1 - \frac{T_0}{T} \quad \dots\dots\dots (A)$$

で示している。

この吸光度 0.1 は菌数 $4 \times 10^7/\text{c.c.}$ であると述べているが、著者等の光電計では $7.5 \times 10^7/\text{c.c.}$ であつた。菌数 $10^7/\text{c.c.}$ 附近は腐敗の初期を示しているので、腐敗初期迄の防腐剤の効果を検討する場合、この吸光度 0.1 は妥当な値と考え、著者等もこの値をとつて各防腐剤の阻害度を求め第 1 表の如き結果を得た。

Table 1. Inhibition coefficient of the mucus.

Preservatives	<i>Escherichia coli</i>					<i>Pseudomonas fluorescens 33F</i>				
	Concentration (M)	Mucus solution added				Concentration (M)	Mucus solution added			
		0 c.c.	1 c.c.	3 c.c.	5 c.c.		0 c.c.	1 c.c.	3 c.c.	5 c.c.
5-Nitro-2-furfural semicarbazone	2.0×10^{-5}	0.64	0.63	0.63	0.64					
Aureomycin	1.2×10^{-5}	0.65	0.65	0.65	0.65	2.0×10^{-5}	0.35	0.26	0.27	0.27
Sulfathiazole	9.8×10^{-5}	0.67	0.58	0.58	0.59	5.9×10^{-5}	0.34	0.29	0.27	0.28
Sodium nitrite						7.2×10^{-2}	0.43	0.36	0.34	0.34
Silver nitrate	8.8×10^{-6}	0.60	0.48	0.15	0.12	1.1×10^{-5}	0.32	0.12	0.10	0.08
Mercuric chloride	3.8×10^{-6}	0.72	0.63	0.45	0.25	2.9×10^{-6}	0.48	0.40	0.33	0.28
Phenol	1.1×10^{-2}	0.46	0.43	0.41	0.40	2.7×10^{-3}	0.28	0.28	0.23	0.24

粘質物の 5-Nitro-2-furfural semicarbazone と Aureomycin に対する阻害作用は *Esch. coli* では全く認められないが、重金属塩に対する作用は顕著であり、その他の防腐剤に対してはそれぞれ略々同様な傾向を示している。

前式 (A) の T_0 は粘質物の存在下における菌の増殖時間であるから、第 1 表の阻害度では粘質物の発育促進効果は無視してもよい。防腐剤の阻害度が粘質物の存在によつて減少していることは、粘質物が増殖促進以外の作用によつても防腐剤と拮抗的に作用していることを示している。

鰯粘質物は第 2 表に示した如く糖蛋白質と推定される。粘質物と金属塩との顕著な拮抗作用は糖蛋白質と重金属との結合作用に基づくものと考えられる。

鰯粘質物は生体の生産物であるから、細菌の原形質と同じ様な化学的性質をもつ物質を含んでいて、防腐剤と反応する細菌成分と競り合つて防腐剤の効力を低める傾向があるのではなからうか。鰯粘質物は糖蛋白質と推定されるので、その溶液はコロイド或はそれに

Table 2. Qualitative analysis of the mucus of Japanese loach.

Ninhydrin Reaction	+	Sakaguchi Test	+
Biuret Test	+	Hopkins-Cole Test	+
Xanthoproteic-Reaction	+	Molisch Test	+
Millon Reaction	+		

近い状態にあつて、防腐剤に対し細菌を保護する作用を示すものと考えられる。原形質毒といわれる硝酸銀、昇汞等を除く他の防腐剤に対する鰯粘質物の阻害度が顕著でないのは、この Protective colloid effect ともいえるものに基づくものであらう。

摘 要

- 1) 魚体粘質物の防腐剤に対する影響を検討するために、鰯の体表面粘質物をブイヨン培地に添加して試験した。
- 2) 鰯粘質物自身は細菌培地としては良好なものではないが、これをブイヨンに添加すると菌の増殖を促進する。
- 3) 鰯粘質物は Sulfathiazole, Aureomycin, 亜硝酸ソーダ, 石炭酸, 昇汞, 硝酸銀と拮抗的に作用する。
- 4) この拮抗作用は鰯粘質物の増殖促進効果のみに因つていてのではない。
- 5) この拮抗作用は重金属塩に対しては特に顕著である。

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Résumé

In order to study the influence of a fish-mucus on the growth of *Escherichia coli* and *Pseudomonas fluorescens* 33 F in the presence of various preservatives, the mucus prepared from a Japanese loach (*Misgurnus anguillicaudatus* (Cantor)) was used, and the following results were obtained.

- 1) Although the mucus is not a suitable medium of bacteria, it shows a tendency to promote the bacterial growth when added in bouillon.
- 2) The mucus has the antagonistic action against sulfathiazole, aureomycin, sodium nitrite, phenol, mercuric chloride and silver nitrate.
- 3) The antagonistic action of the mucus seems due to both the growth-promoting action and the other action.
- 4) The antagonistic action is especially remarkable in the case of heavy metal salts.

Studies on the Antibiotic Action of Fish Components—X. The Antibiotic Action of Carbonyl Compound in Autoxidized Methyl Esters of Fatty Acids Derived from Shark Liver Oil

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In the previous paper¹⁾, it has been described that the antibiotic action of the autoxidized shark liver oil has a close relation with the absorbancy at 530 $m\mu$ which is due to the orange-colored condensed products with thiobarbituric acid (TBA) recently used in estimating rancidity of oil.

When, however, antibiotic activities and TBA values were plotted in a figure, a strict straight line was not observed. It probably means that the antibiotic substances in the autoxidized shark liver oil are the substances colored with TBA, but that the autoxidized oil contains other substances which are colored with TBA and are not the antibiotic substances. In order to prove this by bioautography, *Rf* value of the antibiotic zone and those of the autoxidized products colored with TBA were investigated, and it was shown that *Rf* value of the antibiotic zone agrees with one of *Rf* values of autoxidative products.

Since carbonyl compound is colored with TBA²⁾, the author attempted to separate carbonyl compound from the autoxidized methyl esters of fatty acids derived from shark liver oil. It has been reported that rancid flavor of oxidized oil is due to carbonyl compound, and numerous carbonyl compounds have been isolated as hydrazones from the vapor-distillates³⁾. The author had previously attempted to separate the antibiotic substance from the autoxidized oil by distillation, but in vain, so other separation methods were employed.

Experimental

I. Bioautography of the antibiotic autoxidized fatty acids of shark liver oil fractionated by means of urea

The preparation employed for bioautography were obtained by the following procedure⁴⁾. Fatty acids of shark liver oil were autoxidized in the presence of *M*/100 Cu-stearate by blowing oxygen at 100° for 1.5 hr. and then were fractionated by means of urea (antibiotic activity 2,000). Petroleum ether (b.p. 50°~60°)-acetic acid (4:1) was suitable as a developing solvent and Toyo No. 50 filter paper was used. After developing the chromatogram, the solvent was removed by using ABDERHALDEN's dryer for 10 min. Then the filter paper was cut into each 0.5 cm., and each piece was laid on Peptone-HAYDUCK

agar plate seeded with *Debaryomyces membranaefaciens*, a strain used for the assay of the antibiotics. The agar plates were then incubated for 48 hr. at 30° and R_f value of the zone of growth inhibition was measured. On the other hand, the other filter paper on which chromatogram was developed was sprayed with 0.67 % TBA solution in 50 % acetic acid.

As shown in Fig. 1, R_f value of antibiotic zone agreed with that of a larger orange-colored spot sprayed with TBA reagent, and two smaller spots were present which had no connection with the antibiotic action. It means that the antibiotic substance is a substance which is colored with TBA, and that the other substances, which are colored with it but are not involved in the antibiotic action, are also present in the autoxidized fatty acids of shark liver oil.

II. Separation of carbonyl compound from the antibiotic autoxidized methyl esters of fatty acids derived from shark liver oil

The preparations employed in the study were obtained by the following procedure. Shark liver oil was saponified and then unsaponifiable matter was eliminated. After methylation and distillation, methyl esters distilled at 179°~203° (4 mm.) were obtained. Then these methyl esters were autoxidized according to the procedure described above (antibiotic activity of the autoxidized methyl esters 500).

In order to separate carbonyl compound, the autoxidized methyl esters were fractionated according to GIRARD's method⁶⁾ as shown in the separation chart (Fig. 2). The antibiotic substance was present only in carbonyl fraction and the antibiotic activity was 2,000, whereas non-carbonyl fraction did not show any antibiotic action. Accordingly, the antibiotic substance was concentrated in carbonyl fraction, however the yield of antibiotic activity was only 24 %.

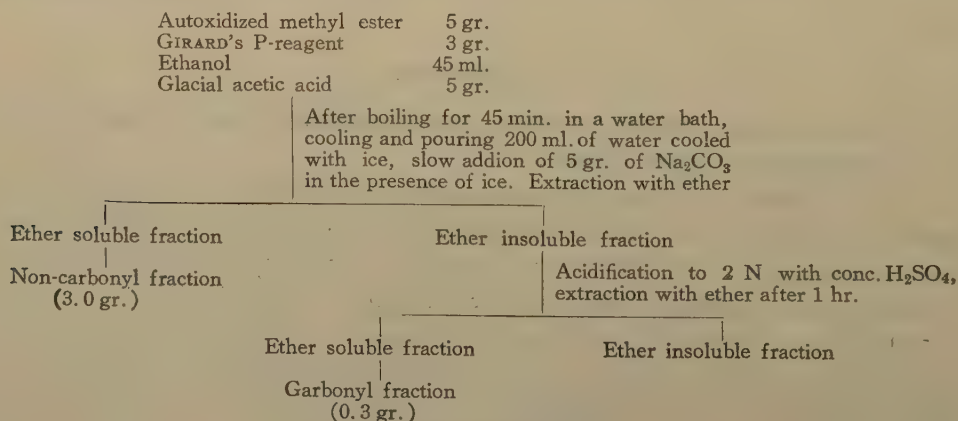


Fig. 2. Separation chart.

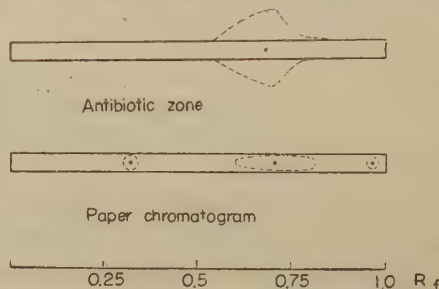


Fig. 1. Bioautography of the antibiotic autoxidized fatty acids of shark liver oil fractionated by means of urea.

To solve the question of the low yield, further study has been made. After treating the autoxidized methyl esters in the absence of P-reagent according to the procedure shown in the separation chart, the antibiotic activity decreased to 200. So it was concluded that the decrease of the antibiotic activity was not due to the neutralization with sodium carbonate or to boiling in ethanol, but to boiling in 10 % acetic acid ethanol solution for 45 min., as shown in Table 1. In boiling the preparations in 10 % acetic acid ethanol solution for 45 min., the same decrease of antibiotic activity was observed with the autoxidized fatty acids of shark liver oil as in the case of the esters, and no decrease was observed with the autoxidized shark liver oil. Therefore, stabilization of the antibiotic substance during the treatment was attempted by adding small amount of the fresh or the autoxidized shark liver oil to the autoxidized fatty acids or methyl esters, but no successful result was found as when some antioxidants were added.

Table 1. Stability of antibiotics for thermal treatment

Sample	Antibiotic activity	Thermal treatment (for 45 min.)	Antibiotic activity
Autoxidized methyl esters of fatty acids derived from shark liver oil	500	Boiling in 10 % acetic acid ethanol solution	200
ditto	500	After boiling in 10 % acetic acid ethanol soln., neutralization with sodium carbonate	200
ditto	500	Boiling in ethanol	500
Autoxidized fatty acids derived from shark liver oil	500	Boiling in 10 % acetic acid ethanol solution	200
Autoxidized shark liver oil	500	ditto	500

Peroxide values of the preparations before and after the thermal treatment in 10 % acetic acid ethanol solution were 7.84 and 6.00 respectively, so the antibiotic action does not appear to be due to peroxide.

Carbonyl compound which was obtained by GIRARD's method was brownish red-colored, slimy and oily substance and the yield of antibiotic activity was low. As thermal treatment which promotes further oxidation should be avoided in the present study, carbonyl compound in the autoxidized methyl esters was separated by preparing addition compound with sodium bisulfite at room temperature, and then following procedure was employed.

10 gr. of the preparations and 20 ml. of saturated bisulfite solution were poured into the flask, and after shaking the flask in a horizontal position for 30 min., the content was centrifuged and then addition compound was obtained in the layer between upper oil and lower saturated sodium bisulfite solution. After washing the addition compound with petroleum ether, it was decomposed by sulfuric acid and then carbonyl fat was extracted with ether. The yields of carbonyl fat and non-carbonyl fat were 0.75 gr. and 7.1 gr. respectively. The antibiotic activity of carbonyl fat was 4,000 and that of non-carbonyl fat could not be recognized at all as in the case of GIRARD's method.

Summary

It was concluded by means of bioautography that the antibiotic substance in the antibiotic autoxidized fatty acids derived from shark liver oil was a main constituent of the

substances which were colored with thiobarbituric acid, and carbonyl compound separated from the autoxidized methyl esters inhibited microbial growth.

Acknowledgement

The author wishes to express his hearty thanks to Prof. Yukio TOMIYASU for his kind advice throughout these works.

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On Copepoda of the family Corycaeidae in
Japanese waters

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On Copepoda of the family Corycaeidae in Japanese waters

OTOHIKO TANAKA

The species belonging to this family are, for the most part, high sea forms and are met with in the warm waters of oceans. The following six species had been known up until 1937 when Mori recorded fourteen species from the neighbouring waters of Japan. They are *C. speciosus* Dana, *C. robustus* Giesbrecht, *C. ovalis* Claus, *C. danae* Giesbrecht (*C. crassiusculus* Dana), *C. anglicus* Lubbock and *C. rostratus* Claus. Among these *anglicus* has been recorded from the European coast of the Atlantic, and the occurrence of this species in the Japanese waters cannot be accepted without further evidence; it is probably identical with the species described by Mori (1937) under the name *japonicus*. Mori recorded in 1937 the following fourteen species: *C. lautus* Dana, *C. speciosus* Dana, *C. crassiusculus* Dana, *C. agilis* Dana, *C. longistylis* Dana, *C. flaccus* Giesbrecht, *C. catus* F. Dahl, *C. latus* Dana, *C. ovalis* Claus, *C. asiaticus* F. Dahl, *C. trukicus* Mori, *C. gibbulus* Giesbrecht, *C. concinnus* Dana and *C. japonicus* Mori. The last species is, as pointed out by Davis (1949), identical with *C. affinis* McMurrich which is abundant in the northeastern Pacific at certain times of the year. The female specimen of *C. trukicus* is immature and doubtful; the male specimen of the species is, in my opinion, identical with the male of *C. andrewsi* Farran. Mori's *C. latus* and *C. catus* appear to be erroneous: the former is identical with *C. catus* F. Dahl, and the latter with *C. pacificus* F. Dahl.

I have collected twenty-three species from the warm waters of the Pacific coast and the Sea of Japan. They are: *C. speciosus*, *C. clausi* F. Dahl, *C. crassiusculus*, *C. viretus* Dana, *C. robustus* Giesbrecht, *C. typicus* Krøyer, *C. flaccus*, *C. limbatus* G. Brady, *C. longistylis*, *C. lautus*, *C. furcifer* Claus, *C. andrewsi* Farran, *C. asiaticus* F. Dahl, *C. subtilis* M. Dahl, *C. dubius* Farran, *C. dahli* nom. nov., *C. affinis*, *C.*

agilis, *C. catus*, *C. pacificus* F. Dahl, *C. rostratus* Claus, *C. gibbulus* and *C. concinnus* Dana. Thus the species taken from the adjacent waters of Japan amount to 24 in number.

About forty-one species of the family Corycaeidae have been reported from the oceans; the following thirteen species from both the Atlantic and Indo-Pacific: *C. rostratus*, *C. gracilis* Dana, *C. speciosus*, *C. clausi*, *C. flaccus*, *C. limbatus*, *C. lautus*, *C. furcifer*, *C. amazonicus* M. Dahl, *C. minimus* M. Dahl, *C. latus*, *C. giesbrechti* F. Dahl and *C. ovalis* Claus; four species from the Atlantic: *C. elongatus* Claus, *C. africanus* F. Dahl, *C. anglicus* Lubbock and *C. huxleyi* Lubbock; the following twenty-four species appear to be of the Indo-Pacific: *C. carinatus* Giesbrecht, *C. brevis* Farran, *C. curtus* Farran, *C. gibbulus* Giesbrecht, *C. concinnus*, *C. crassiusculus*, *C. viretus* Dana, *C. robustus*, *C. typicus* M. Dahl (*C. alatus* Giesbrecht), *C. longistylis*, *C. lubbocki* Giesbrecht, *C. tenuis* Giesbrecht, *C. asiaticus*, *C. erythraeus* Cleve, *C. dubius* Farran, *C. andrewsi*, *C. subtilis* M. Dahl, *C. agilis*, *C. pacificus*, *C. catus*, *C. pumilus* M. Dahl, *C. medius* Gurney, *C. brehmi* Steuer and *C. affinis*.

It is interesting to compare the Japanese species with those taken from the other regions of the Pacific, and from the Indian Oceans. The following number of species have been recorded from these regions: eighteen species from the Ceylon Pearl Fishery Bank by Thomson and A. Scott (1903); nine species from Bombay by Cleve (1903); eleven species from the Maldives and Laccadive Archipelago by Wolfenden (1905); sixteen species from the Malay region by A. Scott (1909); twenty species from the Christmas Island, Indian Ocean by Farran (1911); twenty-seven species from the Indo-Pacific by M. Dahl (1912); four species from the Suez Canal by Gurney (1912); twenty-four species from the Great Barrier Reef by Farran (1936); eleven species from the Indian Ocean by Sewell (1947); twenty-one species chiefly from the Pacific Ocean by Wilson (1950); two species from the San Diego region by Esterly (1905); one species from the northeastern waters of the North Pacific by Davis (1949). Among these species the following twelve species have not been recorded from the Japanese waters: *C. erythraeus* Cleve, *C. amazonicus* F. Dahl, *C. brehmi* Steuer, *C. minimus* F. Dahl (*C. venustus* Dana?), *C. medius* Gurney, *C. pumilus* M. Dahl, *C. curtus* Farran, *C. carinatus* Giesbrecht and *C. pellucidus* Dana (*C. gracilis* Dana?).

It is probable that intensive study of copepoda extends the knowledge on the geographical distribution of the species, but a list of species without description and figures will bring much confusion to the question, and it is never superfluous to give them again.

Description of the species

Genus *Corycaeus* DanaSubgenus *Corycaeus* M. Dahl*Corycaeus (Corycaeus) speciosus* Dana

Plate 3, figs. 1—6

Corycaeus speciosus Giesbrecht, 1892, p. 673, taf. 51, figs. 39, 40.

Corycaeus speciosus A. Scott, 1909, p. 251.

Corycaeus (Corycaeus) speciosus M. Dahl, 1912, p. 13, taf. 1, 2.

Corycaeus speciosus Farran, 1936, p. 134.

Corycaeus speciosus Mori, 1937, p. 133, pl. 72, figs. 9-15.

Corycaeus (Corycaeus) speciosus Sewell, 1947, p. 276.

Corycaeus speciosus Wilson, 1950, p. 196.

Female. Length, 1.86–1.97 mm. Head and 1st thoracic segment partially fused. Posterior corners of 3rd thoracic segment exceed the distal margin of genital segment. Cephalothorax and 2-jointed abdomen in the proportional lengths 14:9. Abdominal segments and furcal rami in the proportional lengths calculated in parts per 100 are 38:16:46. Anterior segment, the head and 1st thoracic segment, is about $\frac{3}{5}$ as wide as long. Long and divergent furcal rami are the characteristic feature of the species.

Male. Length, 1.48–1.62 mm. Head and 1st thoracic segment fused. Proportional lengths of cephalothorax and abdomen 5:4, and those of abdominal segments and furcal rami 33:21:46. Anterior segment is about 1.8 times as long as wide. Genital segment about $\frac{3}{5}$ as wide as long (14:9). Anal segment more than 2 times as wide as long, and is of the same width throughout its length. Furcal rami slender, about 12 times as long as wide. Posterior corners of 3rd thoracic segment exceed the middle of the genital segment.

The species is very common in Japanese waters. According to M. Dahl it is widely distributed in the warm regions of the Pacific, Indian and Atlantic Oceans.

Corycaeus (Corycaeus) clausi F. Dahl

Plate 3, figs. 7—11

Corycaeus ovalis Giesbrecht, 1892, p. 659, taf. 51, figs. 1-3.

Corycaeus (Corycaeus) clausi M. Dahl, 1912, p. 18, taf. 2, figs. 5-12.

Corycaeus clausi Wilson, 1950, p. 193.

Female. Length, 1.50 mm. Cephalothorax, 1.1 mm, abdomen, 0.44 mm. Head fused with 1st thoracic segment. Proportional lengths of abdominal segments and furcal rami 46:22:32. Anterior segment about 1.6 times as long as wide. Genital segment oval, about as wide

as long (22:23). Anal segment wider at the proximal than at the distal (15:11). Furcal rami more than 3 times as long as it is wide at the proximal. Posterior corners of 3rd thoracic segment extend to the two-thirds of the genital segment.

Male. Length, 1.37 mm. Cephalothorax, 0.85 mm., abdomen, 0.52 mm. Proportional lengths of abdominal segments and furcal rami 46:21:33. Genital segment about 2 times as long as wide (7:4). Anal segment is by one-fifth wider at the proximal than at the distal (10:8). Furcal rami about 7 times as long as it is wide at the proximal (20:3).

The species is very rare in Japanese waters. The species has been recorded from the temperate waters of the Atlantic, but rarely from the Indo-Pacific.

Corycaeus (Corycaeus) crassiusculus Dana

Plate 3, figs. 12—15

Corycaeus danae Giesbrecht, 1192, p. 660, taf. 51, figs., 59, 60.

Corycaeus (Corycaeus) crassiusculus M. Dahl, 1912, p. 21, taf. 3, figs. 1-7.

Corycaeus crassiusculus Farran, 1936, p. 134.

Corycaeus crassiusculus Mori, 1937, p. 133, pl. 75, figs. 1-5.

Corycaeus (Corycaeus) crassiusculus Sewell, 1947, p. 272, fig. 69, a-h.

Corycaeus crassiusculus Wilson, 1950, p. 193.

Female. Length, 1.44–1.57 mm. Head separates from 1st thoracic segment. Proportional lengths of cephalothorax and abdomen 21:11, and those of abdominal segments and furcal rami 39:24:37. Anterior segment is about 2 times as long as wide (17:9). Genital segment is about 1.3 times as long as wide. Anal segment little wider at the proximal than at the distal (8:7). Distal margin of the genital segment extends on the dorsal surface over the anal segment. Furcal rami about 6 times as long as it is wide at the proximal. Posterior corners of 3rd thoracic segment extend to the distal end of the genital segment.

Male. Length, 1.27–1.36 mm. Head fused with 1st thoracic segment. Proportional lengths of cephalothorax and abdomen 51:31, and those of abdominal segments and furcal rami 40:21:39. Anterior segment about 1.8 times as long as wide (18:9). Genital segment about 1.5 times as long as wide (26:17). Anal segment little wider at the proximal than at the distal (8:7), and 2 times as long as it is wide at the distal. Furcal rami about 8 times as long as it is wide at the proximal. Posterior corners of 3rd thoracic segment not so slender as in the male of *C. speciosus*, and extend to the middle of the genital segment.

The species is very common in Japanese waters. It is, according to M. Dahl, widely distributed in the Indo-Pacific Ocean and the Mediterranean Sea.

Corycaeus (Corycaeus) viretus Dana

Plate 4, figs. 1—4

Corycaeus (Corycaeus) viretus M. Dahl, 1912, p. 25, taf. 3, figs. 8-13.

Corycaeus viretus Farran 1936, p. 134, fig. 28, a-d.

Corycaeus viretus Wilson, 1950, p. 197.

Male. Length, 1.55–1.60 mm. Body much more inflated than the foregoing species. Cephalothorax 1.5 times as long as abdomen (26:17). Proportional lengths of abdominal segments and furcal rami 55:15:30. Anal segment is wider at the proximal than at the distal (13:11), and is about as long as it is wide at the distal (10:11). Furcal rami 5 times as long as wide (19:4).

The species is rare in Japanese waters. Six male specimens were collected from the Pacific coast of Middle-Japan and from the Sea of Japan. It has been recorded from the Indian Ocean near the west coast of Sumatra.

Subgenus *Monocorycaeus* M. Dahl

Corycaeus (Monocorycaeus) robustus Giesbrecht

Plate 4, figs. 5—8

Corycaeus robustus Giesbrecht, 1892, p. 673, taf. 51, figs. 38, 42.

Corycaeus robustus A. Scott, 1909, p. 251.

Corycaeus (Monocorycaeus) robustus M. Dahl, 1912, p. 27, taf. 4, figs. 1-8.

Corycaeus robustus Farran, 1936, p. 135.

Corycaeus robustus Wilson, 1950, p. 196.

Female. Length, 2.11 mm. Cephalothorax, 1.38 mm, abdomen 0.73 mm. The species is easily distinguished from the other members of the genus by the robust cephalothorax and genital segment. Proportional lengths of abdominal segments and furcal rami 59:12:29. Genital segment 1.4 times as long as wide (10:7).

The species is very rare in Japanese waters. Only a single female specimen was collected from the Pacific coast. The species has been recorded from the tropical region of the Pacific.

Subgenus *Agetus* M. Dahl

Corycaeus (Agetus) typicus Kröyer

Plate 4, figs. 9—15

Corycaeus alatus Giesbrecht, 1892, p. 674, taf. 51, figs. 8, 9.

Corycaeus (Agetus) typicus M. Dahl, 1912, p. 31, taf. 4, figs. 9-14, taf. 5, figs. 1-3.

Corycaeus typicus Farran, 1936, p. 135.

Corycaeus typicus Wilson, 1959, p. 196.

Female. Length, 1.50-1.61 mm. Head separates from 1st thoracic segment. Cephalothorax and abdomen in the proportional lengths 2:1. Genital segment and furcal rami in the proportional lengths 55:45. Inner marginal furcal seta flanged, and longer than the furcal ramus itself. The peculiar form of 4th thoracic segment and abdomen separate the species from the other members of the genus.

Male. Length, 1.50-1.54 mm. Cephalothorax and abdomen in the proportional lengths 8:5. Anterior segment less than 2 times as long as wide (40:23). Abdominal segments and furcal rami in the proportional lengths 52:18:30. Genital segment about 1.5 times as long as wide (33:23). Anal segment little wider at the proximal than at the distal (9:8). Furcal rami more than 6 times as long as it is wide at the proximal (19:3). Terminal claw of 2nd antenna about 2 times as long as the outer-marginal one arising from the proximal of the apical joint. In the other specimen dissected the claw is much shorter (3:2), and the spine of 1st basal joint of 2nd antenna longer than that of 2nd basal joint (4:3), whereas they are of about the same lengths in the ordinary specimen.

The species is fairly common in Japanese waters. Ten females and five males were collected from the Pacific coast. It has been recorded from the Indo-Pacific, the tropical region of the Atlantic and the Mediterranean Sea.

Corycaeus (Agetus) flaccus Giesbrecht

Plate 5, figs. 1-7

Corycaeus flaccus Giesbrecht, 1892, p. 674, taf. 51, figs. 10, 11.

Corycaeus flaccus A. Scott, 1909, p. 248.

Corycaeus (Agetus) flaccus M. Dahl, 1912, p. 35, taf. 5, figs. 4-11.

Corycaeus flaccus Farran, 1936, p. 135.

Corycaeus flaccus Mori, 1937, p. 135, pl. 73, figs. 7-15.

Corycaeus flaccus Wilson, 1950, p. 193.

Female. Length, 1.56-1.67 mm. Head separates from 1st thoracic segment. Cephalothorax and abdomen in the proportional lengths 9:4. Anterior segment 1.8 times as long as wide (47:26). Abdominal segments and furcal rami in the proportional lengths 4:3. Genital segment 1.5 times as long as wide, has a small rounded protuberance on the mid-dorsal of the segment. Lateral margins of genital segment are furnished with short hairs. Inner marginal furcal seta is the longest and is flanged.

Male. Length 1.37-1.39 mm. Cephalothorax and abdomen in the

proportional lengths 5:3. Anterior segment $\frac{3}{5}$ as wide as long. Abdominal segments and furcal rami in the proportional lengths 47:20:33. Genital segment 1.5 times as long as wide (29:19); lateral distal margins of the segment produced when viewed from the dorsal. Anal segment wider at the proximal than at the distal (9:8). Furcal rami 7 times as long as wide (20:3). Terminal claw of 2nd antenna about 2.5 times as long as the outer-marginal one arising from the proximal of the apical joint, and about as long as the spines of the basal joints. Inner margin of 2nd basal joint has no large tooth, but is finely serrated.

The species is rather rare in Japanese waters. Seven females and three males were collected from the Pacific coast, and one male from the Japan Sea. The species is distributed in the warm waters of the Atlantic, especially in the Sargassum Sea, Mediterranean and Indo-Pacific.

Corycaeus (Agetus) limbatus G. Brady

Plate 5, figs. 8—12

Corycaeus elongatus Giesbrecht, 1892, p. 674, taf. 51, fig. 6.

Corycaeus (Agetus) limbatus M. Dahl, 1912, p. 38, taf. 5, figs. 12-14, taf. 6, figs. 1-5.

Corycaeus limbatus Farran, 1936, p. 136.

Corycaeus limbatus Wilson, 1950 p. 194.

Female. Length, 1.36 mm. Cephalothorax, 1.00 mm., abdomen, 0.36 mm. One-jointed abdomen is 2 times as long as furcal rami. The rhomboidal form of genital segment in dorsal aspect is a good specific character of the female.

Male. Length, 1.22 mm. Cephalothorax, 0.77 mm, abdomen, 0.45 mm. Abdominal segments and furcal rami in the proportional lengths 52:17:29. Anterior segment less than 2 times as long as wide (7:4). The large cuticular lenses are contiguous. Genital segment about 1.6 times as long as wide (27:17). Anal segment is of the same width throughout its length, and 1.5 times as long as wide. Furcal rami 5 times as long as wide. Terminal claw of 2nd antenna about 2.5 times as long as the outer-marginal one.

The species is rare in Japanese waters. Three females and one male were collected from the Pacific coast. The species is distributed in the warm waters of the Atlantic and Indo-Pacific.

Subgenus *Urocorycaeus* M. Dahl

Corycaeus (Urocorycaeus) longistylis Dana

Plate 5, figs. 13—16

Corycaeus longistylis Giesbrecht, 1892, p. 674, taf. 51, fig. 37.

Corycaeus (Urocorycaeus) longistylis M. Dahl, 1912, p. 42, taf. 6, 7.

Corycaeus longistylis A. Scott, 1909, p. 249.

Corycaeus longistylis Farran, 1936, p. 136.

Corycaeus longistylis Mori, 1937, p. 134, pl. 73, figs. 3-8.

Corycaeus (Urocorycaeus) longistylis Sewell, 1949, p. 277.

Corycaeus longistylis Wilson, 1950, p. 195.

Female. Length, 2.80 mm. Head fused with 1st thoracic segment. Third and fourth thoracic segments completely fused. Cephalothorax little longer than the combined length of abdominal segments and furca. Lateral corners of 3rd thoracic segment produced posteriorly to about the distal 1/3 of genital segment. Abdominal segments and furcal rami in the proportional lengths 21:21:58. Dorsal surface of genital segment vaulted. Furcal ramus slender and long, about 16 times as long as it is wide at the proximal.

Male. Length, 2.13-2.19 mm. Cephalothorax and abdomen in the proportional lengths 31:29. Abdominal segment and furcal rami are in the proportional lengths 13:18. Terminal claw of 2nd antenna about 3 times as long as the proximal outer-marginal one. There is a row of small teeth on the outer margin and the median line of 2nd basal joint of 2nd antenna.

The species is fairly common in Japanese waters. One female and fourteen males were collected from the Pacific coast. The species has been recorded only from the Pacific. Mori recorded the species from the southern waters of Japan.

Corycaeus (Urocorycaeus) lautus Dana

Plate 6, figs. 1-2

Corycaeus (Urocorycaeus) lautus M. Dahl, 1912, p. 45, taf. 7, figs. 4-14.

Corycaeus lautus Farran, 1936, p. 136.

Corycaeus lautus Mori, 1937, p. 132, pl. 72, figs. 1-8.

Corycaeus lautus Wilson, 1950, 194.

Male. Length, 2.29-2.32. Cephalothorax and abdomen in the proportional length 31:33. Abdominal segments and furcal rami in the proportional lengths 25:18:57. Proximal tooth on the inner distal margin of 2nd basal joint of 2nd antenna very sharp. Process of 2nd basal joint of 4th leg is furnished, beside a normal long seta, with a short one.

The species is rather rare in Japanese waters. Four males were collected from the Pacific coast. It has been recorded from the Sargassum Sea, the adjacent sea of New Guinea, and Pacific Ocean (113°W 13°S). Mori collected the species from the southern warm waters of Japan.

Corycaeus (Urocorycaeus) furcifer Claus

Plate 6, figs. 3—6

Corycaeus furcifer Giesbrecht, 1892, p. 674, taf. 51, figs. 41, 44-46.*Corycaeus furcifer* A. Scott, 1909, p. 248.*Corycaeus (Urocorycaeus) furcifer* M. Dahl, 1912, p. 48, taf. 8, figs. 1-7.*Corycaeus furcifer* Farran, 1936, p. 136.*Corycaeus furcifer* Wilson, 1950, p. 193.

Female. Length, 19.2 mm. Cephalothorax, 1.02 mm, abdomen, 0.90 mm. Abdominal segments and furcal rami in the proportional lengths 20:12:68. Lateral processes of 3rd thoracic segment extend to the proximal 1/3 of genital segment. Genital segment has a rounded process on the dorsal surface about the middle. Anal segment has two sharp spines on the dorsal surface at the distal margin.

The species is very rare in Japanese waters. A single female specimen was collected from the Pacific coast. It has been recorded from the Indo-Pacific, northern coast of South America, Mediterranean and Sargassum Seas.

Subgenus *Ditrichocorycaeus* M. Dahl

The species of this subgenus are, as Sewell (1947) pointed out, the most difficult of all copepods to discriminate. According to the key of the species given by M. Dahl they are divided into two. The first group has short furcal rami which are about as long as anal segment but shorter than genital segment; to this group belong *C. andrewsi*, *C. asiaticus* and *C. subtilis* M. Dahl. The second group is characterized by the possession of furcal rami which are longer than both anal segment and genital segment; to this group belong *C. amazonicus* F. Dahl, *C. anglicus* Lubbock, *C. minimus* M. Dahl, *C. tenuis* Giesbrecht, *C. lubbocki* Giesbrecht, *C. africanus* F. Dahl, *C. dubuis* Farran, *C. tenuis* Farran, *C. erythraeus* Cleve and *C. lubbocki* M. Dahl. Among those *C. lubbocki* Giesbrecht, *C. tenuis* Giesbrecht and *C. minimus* have no ventral hook on the genital segment in the female. M. Dahl (1912) described from the material taken in Sansibar, Ceylon and the China Sea, the species which had a ventral hook under the name *lubbocki*, and concluded that *C. tenuis* Farran is identical with her *lubbocki*. However, Sewell disagreed with M. Dahl's opinion and states that Giesbrecht's *lubbocki* which has no ventral hook is not identical with Dahl's *lubbocki*, and the true *lubbocki* Giesbrecht was redescribed in 1924 by Früchtl under the name *farrani*. He further states that *tenuis* Farran (non Giesbrecht) and *lubbocki* M. Dahl (non Giesbrecht) are probably synonymous, and both of them are synonymous of *C. africanus* F. Dahl. I have now three species of *Ditrichocorycaeus* belonging to

the second group; one of them is, without doubt, identical with *tenuis* Farran; the other two appear to be *dubius* Farran and *japonicus* Mori respectively. The last species is one of the most common one in the warm waters of Japan, and is synonymous, as indicated by Chales C. Davis (1949), with *C. affinis* McMurrich.

Corycaeus (Ditrichocorycaeus) andrewsi Farran

Plate 6, figs. 7—12

Corycaeus andrewsi Farran, 1911, p. 294, pl. 13, 14.

Corycaeus (Ditrichocorycaeus) andrewsi M. Dahl, 1912, p. 78, taf. 9, figs. 10-18.

Corycaeus andrewsi Farran, 1936, p. 138

Corycaeus trukicus Mori, 1937, p. 137, pl. 75, figs. 9-16.

Female. Length, 1.00–1.07 mm. Cephalothorax and abdomen in the proportional lengths 2:1. Head separates from 1st thoracic segment. Distal corners of 3rd thoracic segment produced into small wing-like expansions. Distal corners of 4th thoracic segment not extending to the middle of genital segment. Abdominal segments and furcal rami in the proportional lengths 47:29:24. There are two groups of fine hairs on the ventral surface of genital segment when viewed from the lateral, but no ventral hook. Inner marginal spine of 2nd basal joint of 2nd antenna about $\frac{3}{5}$ times as long as that of 1st joint.

Male. Length, 0.82–0.88. Cephalothorax and abdomen in the proportional lengths 29:19. Abdomal segments and furcal rami in the proportional lengths 58:21:21. Anterior segment 1.5 times as long as wide (42:27). 2nd thoracic segment has on the lateral margins each a slight swelling about the middle. Genital segment $\frac{4}{5}$ as wide as long, broadish oval in shape, and has a small ventral hook. Anal segment is of about the same width throughout its length, and 1.5 times as long as wide. Furcal rami 4 times as long as it is wide at the proximal. Wing-shaped expansions of 3rd thoracic segment extend to proximal $\frac{1}{3}$ of genital segment. There is a longitudinal median row of spinules on 2nd basal joint of 2nd antenna.

Remarks. *Corycaeus trukicus* Mori belongs to the subgenus *Ditrichocorycaeus*. His female specimen has coarsely plumosed spines on each of the 1st and 2nd basal joints of 2nd antenna; this is a characteristic feature of the immature specimen of *Corycaeus* (sensu lato) except the subgenus *Corycella* Farran. *C. trukicus* is closely allied to *C. andrewsi*, *C. asiaticus*, and *C. subtilis* in having short furcal rami which are about as long as anal segment. His specimens measured 0.65–0.95 mm in female, and 0.8 mm in male. The female specimens deviate too much in total length. The smallest species among *Ditrichocorycaeus* is, according to M. Dahl, *C. subtilis* M. Dahl which measures 0.75–0.77 mm in female. *C. trukicus* differs from *C.*

subtilis in having a prolonged 4th thoracic segment, and a long plumose spine on the 2nd basal joint of 2nd antenna. The male specimen of *C. trukicus* agrees fairly well with the male of *C. andrewsi* in having furcal rami which are about as long as anal segment, and in having short wing-like expansions on the 3rd thoracic segment. My male specimen has on the lateral margins of 2nd thoracic segment a slight swelling on each side about the middle. This is clearly illustrated by Mori in his figure of the male specimen of *trukicus*.

This is one of the most common species in Japanese waters. Ten females and sixteen males were collected from the Pacific coast. The species has been recorded from the Indo-Pacific Ocean. Mori recorded the occurrence of the species from the station near Truk Island.

Corycaeus (Ditrichocorycaeus) asiaticus F. Dahl

Plate 6, figs. 13—19

Corycaeus murrayi Farran, 1911, p. 294, pl. 13, figs. 1-6.

Corycaeus (Ditrichocorycaeus) asiaticus M. Dahl, 1912, p. 74, taf. 11, figs. 1-9.

Corycaeus asiaticus Gurney, 1926, p. 163 fig. 24, a-c.

Corycaeus asiaticus Farran, 1936, p. 137.

Corycaeus asiaticus Mori, 1937, p. 136, pl. 75, figs. 6-8.

Corycaeus (Ditrichocorycaeus) asiaticus Sewell, 1947, p. 281.

Female. Length, 1.15-1.19 mm. Cephalothorax and abdomen in the proportional lengths 15:8. Anterior segment 1.6 times as long as wide. Abdominal segments and furcal rami in the proportional lengths 42:29:29. Genital segment about as long as wide (20:28), has no ventral hook; proximal ventral corner of the segment rectangular. Anal segment about as long as it is wide at the proximal (14:12); the proximal margin of segment 1.5 times as wide as it is wide at the proximal (12:8). Furcal rami 5 times as long as wide (14:3). Distal margin of 2nd basal joint of 2nd antenna has a small tooth distal to the large one. Apical spine of exopodite of 2nd leg is curved and without peculiar serration.

Male. Length, 1.04-1.12 mm. Cephalothorax and abdomen in the proportional lengths 3:2. Anterior segment 1.6 times as long as wide (14:9). Wing-like expansions of 3rd thoracic segment extend posteriorly about to the middle of genital segment. Abdominal segments and furcal rami in the proportional lengths 49:24:27. Genital segment 1.3 times as long as wide (23:18). Anal segment is of the same width throughout its length, and about 2 times as long as it is wide at proximal. Furcal rami about 6 times as long as it is wide at the middle of the ramus (25:4). Ventral hook of genital segment shows some individual difference.

The species is rather rare in Japanese waters. Four females and

three males were collected from the Pacific coast and one female from the Sea of Japan. It has been recorded from the Indo-Pacific.

Corycaeus (Ditrichocorycaeus) subtilis M. Dahl

Plate 7, figs. 1—4

Corycaeus (Ditrichocorycaeus) subtilis M. Dahl, 1912, p. 80, taf. 8, figs. 9–16.

Corycaeus subtilis Farran, 1936, p. 138.

Corycaeus subtilis Wilson, 1950, p. 196.

Female. Length, 0.76 mm. Cephalothorax, 0.52 mm, abdomen, 0.24 mm. Abdominal segments and furcal rami in the proportional lengths 44:26:30. Wing-like expansions of 3rd thoracic segment not extending to the middle of genital segment. Processes of posterior corners of 4th thoracic segment very small. Apical spine of exopodite of 2nd leg has two teeth on the inner anterior side.

The species is very rare in Japanese waters. Two females were collected from the Pacific coast. It has been recorded from the Indo-Pacific.

Corycaeus (Ditrichocorycaeus) dubius Farran

Plate 7, figs. 5—13

Corycaeus dubius Farran, 1911, p. 292, pl. 12, 14.

Corycaeus (Ditrichocorycaeus) dubius M. Dahl, 1912, p. 71, taf. 10, figs. 11–19.

Corycaeus erythraeus Gurney, 1926, p. 161, fig. 23, a–d.

Corycaeus erythraeus Farran, 1936, p. 137.

Corycaeus dubius Wilson, p. 193.

Female. Length, 1.09 mm. Cephalothorax, 0.65 mm, abdomen, 0.44 mm, so the abdomen is contained about 5 times in the length of the cephalothorax. Cephalothorax rather slender, about 2.4 times as long as wide (90:38). Head separates from thoracic segment. Posterior corners of 3rd thoracic segment exceed slightly beyond the middle of genital segment. 4th thoracic segment short, with sharp points. Proportional lengths of abdominal segments and furca measured ventrally 31:33:36; another specimen measuring 1.04 mm in overall length has the proportional length 29:35:36. Genital segment about 1.3 times as long as wide with a sharp hook directing posteriorly at the proximal corner of the segment when viewed from the lateral. The sides of 2nd abdominal segment parallel, about 2.5 times as long as wide. Furcal rami slightly divergent, 10 times as long as wide. The spine arising from 2nd basal joint of 2nd antenna slightly less than $\frac{1}{3}$ the length of that from 1st basal joint, reaches the middle of the joint. Apical spine of exopodite of 2nd leg has about 5 teeth on the inner anterior side.

Male. Length, 0.836 mm. Cephalothorax, 0.45 mm, abdomen, 0.386 mm, so the abdomen is contained 1.2 times in the length of cephalothorax. Posterior corners of 3rd thoracic segment do not extend to the middle of genital segment. Abdominal segments and furcal rami in the proportional lengths 39:26:35. This proportion differs slightly from those given by M. Dahl (40.3:24.2:35.5) or Gurney (41.8:24.0:34.2). Teeth on the inner distal margin of 2nd basal joint of 2nd antenna stronger than those figured by M. Dahl. The characteristic teeth on the inner anterior side of the apical spine of the exopodite of 2nd leg not observed in the male specimen.

The species is rare in Japanese waters. A single male from the Pacific coast and two females from the Sea of Japan. The species has been recorded from the tropical regions of the Pacific and Indian Oceans, and also from the Suez Canal.

Remarks. The present specimen, though slightly larger in size than those of Farran (female 0.97 mm, from Christmas Island; female 0.96–1.02 mm, male 0.84–0.91 mm from the Great Barrier Reef), agrees quite well with his description and figures of *C. dubius*. Gurney (1927, p. 161) states that his *erythraeus* collected from the Suez Canal are probably be identical with *erythraeus* Cleve taken from the Red Sea. Farran (1936, p. 137), regarding Gurney's identification as correct, is of opinion that his *dubius* is identical with *erythraeus* Cleve. I agree that *erythraeus* Gurney is a synonym of *dubius* Farran, as both specimens have the similar structure in the 2nd antenna. It seems probable that these species may be synonymous but one cannot prove it until the doubtful species, *erythraeus* Cleve will be more fully described.

Corycaeus (Ditrichocorycaeus) dahli sp. nov.

Plate 7, figs. 14–17, Plate 8, figs. 1–5

Corycaeus (Ditrichocorycaeus) lubbocki M. Dahl, 1912, p. 64, taf. 10, figs. 20–28.

Corycaeus tenuis Farran, 1911, p. 291, pl. 12, figs. 8–9.

Corycaeus (Ditrichocorycaeus) africanus Sewell, 1947, p. 279, text-fig. 70, a–d.

Female. Length, 1.03–1.08 mm. Cephalothorax about 1.7 times as long as abdomen (68:40). Abdominal segments and furcal rami in the proportional lengths 35:23:42. Anterior segment 1.83 time as long as wide (53:29). Posterior corners of 3rd thoracic segment extend beyond the middle of genital segment. Fourth thoracic segment produced into short pointed processes. Genital segment about 1.3 times as long as wide; dorsal surface of the segment vaulted; there is a folding on the distal 2/3 of the dorsal surface; the ventral surface rather flat. Anal segment wider at the proximal than at the distal, and is 2.6 times as long as it is wide at the distal. Furca divergent,

about 16 times as long as it is wide at the distal. The spine arising from 1st basal joint of 2nd antenna 2 times as long as that from 2nd basal. Apical spine of exopodite of 2nd leg curved, and has about 6 teeth on the inner anterior side.

Male. Length, 0.89–0.91 mm. Abdomen is contained 1.4 times in the length of cephalothorax (57:41). Cephalothorax 1.5 times as long as wide (19:12.5). Proportional lengths of abdominal segments and furcal rami 50:18:32. Genital segment oval in shape, 1.6 times as long as wide (35:21); ventral surface of the segment has a small median hook; cylindrical part of the segment about 1.5 times as long as it is wide at the proximal (14:9). Furcal rami 8 times as long as wide (25:3); the longest furcal seta longer than the furcal ramus itself. In 2nd antenna terminal claw is longer than 2nd basal joint, and 3 times as long as proximal hook of terminal joints; spine arising from 1st basal joint of 2nd antenna little longer than that of 2nd joint. Apical spines of exopodite of the first three legs are straight. Outer-edge spine of 3rd joint of exopodite of 4th leg longer than half the length of 3rd joint (3:4); outeredge spine of 1st joint of exopodite about half as long as 1st joint of the same leg.

Remark. Nine species of *Ditrichocorycaeus* have been reported which resemble each other so closely that considerable confusion has arisen in regarding the species. They are *C. lubbocki* Giesbrecht, *C. lubbocki* M. Dahl, *C. lubbocki* Sewell, *C. tenuis* Giesbrecht, *C. tenuis* Farran, *C. tenuis* M. Dahl, *C. africanus* F. Dahl, *C. africanus* Sewell and *C. brehmi* Steuer. Proportional lengths of abdominal segments and furca of the species in parts per 100 as follows:

	Total length mm.	Genital	2nd	Furcal ramus
<i>C. lubbocki</i> Giesbrecht	0.95	37	17	46
<i>C. lubbocki</i> Sewell	1.033	37.2	15.2	47.6
<i>C. lubbocki</i> M. Dahl	0.95–0.97	35.2	22.5	42.3
<i>C. tenuis</i> Giesbrecht	0.87	37	21	42
<i>C. tenuis</i> Farran	1.05	35	20	45
<i>C. tenuis</i> M. Dahl	0.81–0.84	34.5	22.4	43.1
<i>C. africanus</i> M. Dahl	1.01–1.03	37.5	18.75	43.75
<i>C. africanus</i> Sewell	—	35.5	22.1	42.4
<i>C. brehmi</i>	0.95–1.10	41.8	18.6	39.6
Present specimens	1.03–1.08	35	23	42

Putting aside *lubbocki* Giesbrecht, *tenuis* Giesbrecht and *lubbocki* Sewell which have no ventral hook, and *C. brehmi*, the remaining five have no remarkable difference between them. It is clear that *C. lubbocki* M. Dahl is, according to the description and figures given by both

Giesbrecht and Sewell (1947, p. 281), not identical with *C. lubbocki* Giesbrecht. M. Dahl's *lubbocki* is, as she states, the synonym of *C. tenuis* Farran. Sewell described a form which was taken from the Indian Ocean, and referred it to *C. africanus* F. Dahl. However, his specimen is more closely allied to *C. lubbocki* M. Dahl than to *africanus* in having the abdominal segments and furcal rami which are nearer in the proportional lengths to those of *lubbocki* M. Dahl. Moreover, the spine of 1st basal joint of 2nd antenna is, according to Sewell's figure, less than 3 times the length of that of the 2nd basal joint, whereas it is 3 times in *africanus*. It is probable that *lubbocki* M. Dahl and *tenuis* Farran are, as M. Dahl pointed out, synonymous. Sewell is of opinion that both *tenuis* Farran and *lubbocki* M. Dahl are synonyms of *africanus*, but it seems to me that he is not correct. *C. africanus* differs from those two forms not only in the proportional lengths of the abdomen, but also in its geographical distribution. Sewell's record of *africanus* from the Indo-Pacific seems to be a conjecture. He was forced to choose one of these species, *tenuis*, *lubbocki* and *africanus*. Consequently, he picked up *africanus* which had been recorded from the west coast of Africa, and referred his specimen to it. His single specimen agrees, as he states, with *tenuis* Farran. The present specimen comes near to *lubbocki* M. Dahl, *tenuis* Farran and *africanus* Sewell in the proportional lengths of abdominal segments and furca, also in the total lengths. But I am not sure that the specimen is quite identical with the latter three species, as no mention has been made by the authors on the possession of the serration along the inner anterior side of the apical spine of exopodite of 2nd leg. This serration is apt to be overlooked when it is wrongly situated under microscope. For instance, two figures of the same apical spine viewed in two different aspects are given (plate V, fig. 17); it is easily overlooked when laid as shown in fig. 17, left. I have detected such serration in *C. dubius* Farran, the present specimen and *C. affinis*. The serration appears to be a characteristic feature of some of the female specimens of *Ditrichocorycaeus*. In my opinion, *lubbocki* M. Dahl, *tenuis* Farran and *africanus* Sewell and the present specimen are synonymous. Here I propose, to avoid further confusion, and to give a new name *dahli* to the specimen which has the characteristics as shown in the descriptive note. I wished the name *farrani*, but the name had been reoccupied by Früchtl. Dr. A. Fleminger of Harvard University has recently sent me specimens of *Corycaeus* (*Ditrichocorycaeus*) *americanus* taken from the Gulf of Mexico which appears to be new to science. The female specimen have total lengths 1.12–1.31 mm; abdominal segments and furcal rami in the proportional lengths 28:15:57. The species is characterized by its long furcal rami. The male specimen measured 0.90–1.01 mm in total length.

The species is rather rare in Japanese waters. Four females and eight males were collected from the Sea of Japan, and three males from the Pacific coast. It has been recorded from the tropical regions of the Pacific and Indian Oceans, also from the Great Barrier Reef Sea.

Corycaeus (Ditrichocorycaeus) affinis McMurrich

Plate 8, figs. 6--15

Corycaeus japonicus Mori, 1937. p. 138, pl. 76, figs. 1-11.

Corycaeus affinis Davis, 1949, p. 75, figs. 179-183.

Female. Length, 1.01-1.25 mm. Proportional lengths of cephalothorax and abdomen 77:43, and those of abdominal segments and furcal rami 36:26:38. Anterior segment 1.8 times as long as wide (31:27). Genital segment $\frac{3}{4}$ as wide as long. Anal segment little wider at the proximal, and less than 2 times as long as it is wide at the distal (11:6). Furcal rami 1.7 times as long as anal segment (17:10), and about 9 times as long as it is wide at the proximal (17:2); the rami divergent. Dorsal surface of genital segment vaulted, and the vaulted portion is slightly folded between the genital flaps; ventral surface of genital segment produced prominently below at the middle. In 2nd antenna 2nd basal joint 2 times as long as wide; spine arising from 1st basal joint 3 times as long as that from 2nd basal. Apical spine of exopodite of 2nd leg rather straight, has two or sometimes three teeth on the inner anterior side. Outer-edge spine of 3rd joint of exopodite of 4th leg longer than half the length of the joint itself; outer edge spine of 1st joint of exopodite shorter than half the length of the joint.

Male. Length, 0.83 mm. Cephalothorax 1.6 times as long as abdomen (51:38). Proportional lengths of abdominal segments and furcal rami 50:22:28. Eyes separated by about $\frac{1}{3}$ the greatest diameter. Anterior segment about half the total length of body, $\frac{3}{5}$ as wide as long (31:50). 3rd thoracic segment has sharp backward pointing wings which extend to proximal $\frac{1}{3}$ of the genital segment. The demarcation between 3rd and 4th thoracic segments indistinct. 4th thoracic segment produced into small pointed processes. Genital segment 1.7 times as long as wide (20:12); ventral surface of the segment furnished with a ventrally pointing hook; cylindrical part of the segment about $\frac{1}{3}$ the length of the distal margin of the segment. Anal segment 1.6 times as long as it is wide at the distal (8:5). Furcal rami straight, are of about equal width throughout its length; they are about 6 times as long as wide (11:2); the longest seta is about twice as long as furcal ramus (19:11). Inner margin of 2nd basal joint of 2nd antenna furnished with two teeth, one of which very strong; outer

margin of 2nd basal joint is furnished with fine teeth; the anterior surface is also furnished with a row of very fine teeth. Spine arising from 1st basal joint of 2nd antenna $5/4$ as long as that from 2nd basal which is furnished with fine hairs. Apical spine of exopodite of 1st leg curved outwardly; that of 2nd leg also curved, and is shorter than that of 3rd leg. Apical spine of exopodite of 3rd leg is straight, and is longer than the 3rd joint of exopodite. 4th leg has two setae on the process of 2nd basal joint; outer-edge spine of 1st joint of exopodite $2/3$ the length of the 1st joint, and shorter than that of 3rd joint of exopodite which is about as long as the 3rd joint itself.

Remarks. The present female specimen is closely allied to the foregoing species in its general appearance. However, it differs from *dahli* in the proportional lengths of abdominal segments and furcal rami, namely furcal rami are much shorter in the present specimen. Apical spine of exopodite of 2nd leg is straight, and the teeth of inner anterior side is less in number. The male specimen has the abdomen which differs also in the proportional lengths from those of *dahli*.

C. Davis states that *japonicus* Mori is identical with *affinis* McMurrich (1916) which is abundant in the waters near Friday Harbor, Washington at certain times of the year. According to his description the proportional lengths of abdominal segment and furcal rami of female are 10:6:10 (38.4:23.2:38.4=100); genital segment is as long as furcal ramus. Mori does not mention the proportional lengths of abdominal segments and furca of the female but his figure illustrates that the proportional lengths measured dorsally are 38:24:38, which come very near to my measurements; the genital segment has a folding on the dorsal surface. Thus these characteristics of a female specimen of *japonicus* agree well with those of *C. affinis* described by Davis. The male specimen of *japonicus* has the abdomen quite similar in proportional lengths to those of *affinis*. Mori's specimens measured about 1.1 mm in female, and 0.9 mm in male. Davis's measured 1.1 mm in female, 0.82-0.9 mm in male. *C. anglicus* Lubbock which has been recorded by some of the Japanese authors from the Japanese waters is probably identical with the present species.

The species is the most common one in the warm waters of Japan. It appears to have a wide distribution in the North Pacific, and has been recorded from the east and west coasts of Vancouver Island, Friday Harbor, Washington. It has been recorded by Mori from southern waters of the Pacific coast, and from the Inland Sea, and also from the Sea of Japan. I have detected the species from both the Pacific coast and from the Sea of Japan.

Subgenus *Onychocorycaeus* M. Dahl*Corycaeus (Onychocorycaeus) agilis* Dana

Plate 8, figs. 16—18, Plate 9, figs. 1—5

Corycaeus gracilicaudatus Giesbrecht, 1892, p. 674, taf. 51, figs. 15, 30.*Corycaeus (Onychocorycaeus) agilis* M. Dahl, 1912, p. 84, taf. 12.*Corycaeus agilis* Farran, 1936, p. 138.*Corycaeus agilis* Mori, 1937, p. 72, figs. 1-2.*Corycaeus (Onychocorycaeus) agilis* Sewell, 1947, p. 284.*Corycaeus agilis* Wilson, 1950, p. 192.

Female. Length, 0.88–1.00 mm. Cephalothorax robust, 1.5 times as long as abdomen. Abdominal segments and furcal rami slender, has proportional lengths 35:28:36.

Male. Length, 0.71–0.74 mm. Cephalothorax and abdomen in proportional lengths 47:36. Abdominal segments and furcal rami in proportional lengths 40:27:33. Genital segment is in the oval part $\frac{3}{4}$ as wide as long. Some specimens had each a minute median hook on the ventral proximal corner of genital segment. The specimen from the Japan Sea measured 1.04 mm in female, and 0.79–0.81 mm in male.

The species is widely distributed in the warm waters of Japan, and has been recorded from the tropical regions of the Atlantic, Pacific and Indian Oceans.

Corycaeus (Onychocorycaeus) catus F. Dahl

Plate 9, figs. 6—12

Corycaeus obtusus Giesbrecht, 1892, p. 673, taf. 51, figs. 12-14.*Corycaeus catus* Farran, 1911, p. 290, pl. 12, figs. 1-3.*Corycaeus (Onychocorycaeus) catus* M. Dahl, 1912, p. 99, taf. 13, figs. 17-24.*Corycaeus catus* Farran, 1936, p. 138.*Corycaeus latus* Mori, 1937, p. 136, pl. 74, figs. 8-10.*Corycaeus (Onychocorycaeus) catus* Sewell, 1947, p. 284.*Corycaeus catus* Wilson, 1950, p. 192.

Female. Length, 0.93–1.00 mm. Body robust. Abdomen is contained more than 2 times in the length of cephalothorax (9:4). Abdominal segments and furcal rami in the proportional lengths 58:20:22. Anal segment shorter than it is wide at the proximal (7:8). Furcal rami about 4 times as long as wide (14:4). Outer-edge spine of 1st joint of exopodite of 4th leg long, and exceeds the proximal end of 2nd joint; outer edge spine of 3rd joint is about as long as the 3rd joint of exopodite.

Male. Length, 0.80–0.90 mm. Head separates from 1st thoracic segment. Abdomen is contained 1.5 times in the length of cephalothorax (60:38). Abdominal segments and furcal rami in the proportional lengths 59:19:22. Genital segment has a ventral median hook.

Apical spine of exopodite of 2nd. leg is straight but curved slightly inwards near the distal end, and the serrated outer margin is continued towards the inner margin near the apex.

Mori's *latus* is identical with the present species in having similar proportional lengths in abdominal segments and furcal rami, and the slender wing-like expansion of 4th thoracic segment in the female. His male specimen of *C. latus* has also general resemblance to the male specimen of *C. catus* F. Dahl in the total length and also in the proportional lengths of abdominal segments and furcal rami.

The species is very common in the warm waters of Japan. It has been recorded from the Indo-Pacific Ocean, Great Barrier Reef Sea, and Arabian Sea.

Corycaeus (Onychocorycaeus) pacificus F. Dahl

Plate 9, figs. 13-29

Corycaeus (Onychocorycaeus) pacificus M. Dahl, 1912, p. 103, taf. 14.

Corycaeus pacificus Farran, 1936, p. 139.

Corycaeus catus Mori, 1937, p. 74, figs. 1-7.

Corycaeus (Onychocorycaeus) pacificus Sewell, 1947, p. 285.

Corycaeus pacificus Wilson, 1950, p. 195.

Female. Length, 1.12-1.21 mm. Cephalothorax robust. Abdomen is contained about 2 times in the length of cephalothorax (88:42). Third thoracic segment is very wide; posterior corners of the segment extend to $\frac{3}{4}$ of the genital segment. Wings of 4th thoracic segment short and bluntly pointed. Abdominal segments and furcal rami in the proportional lengths 56:22:22. Genital segment 1.4 times as long as wide (24:17). Anal segment wider at the proximal than at the distal (2:6), and as long as it is wide at the proximal (9:8). Furcal rami about 5 times as long as wide (9:2). Apical spine of exopodite of 2nd leg straight, and has an isolated tooth on the inner margin near the apical portion.

Male. Length, 0.99-1.09 mm. Abdomen is contained 1.2 times in the length of the cephalothorax (64:46). Abdominal segments and furcal rami in the proportional lengths 54:21:25. Genital segment oval, and 1.5 times as long as wide (26:17). Anal segment about 2 times as long as wide (11:6). Furcal rami 8 times as long as wide (12:1.5). Genital segment is devoid of ventral hook.

Mori's *catus* is clearly identical with *C. pacificus*; his female specimen of *catus* has narrowly rounded forehaed and large wing-like expansions on the 3rd thoracic segment extending beyond the middle of the genital segment. His male specimen of *catus* differs from mine in having a ventral hook on the genital segment, and also in the proportional lengths of the abdominal segments and furcal rami.

The species is very common in Japanese waters. The species has a wide distribution in the Pacific and Indian oceans.

Subgenus *Corycella* Farran

Corycaeus (Corycella) rostratus (Claus)

Corycaeus rostratus Giesbrecht, 1892, p. 674, taf. 5, 9.

Corycaeus rostratus Thompson and A. Scott, 1903, p. 285.

Corycaeus rostratus Steuer, 1910, p. 31.

Corycaeus (Corycella) rostratus M. Dahl, 1912, p. 111, taf. 5.

Male. Length, 0.69 mm. Cephalothorax, 0.44 mm, abdomen, 0.25 mm. Genital segment $\frac{1}{3}$ as wide as long. Furcal rami 3 times as long as wide.

The species is very rare. A single male specimen was collected from the Pacific coast. The species is distributed in the subtropical regions of the Pacific and Atlantic Oceans, also in the Mediterranean Sea.

Corycaeus (Corycella) gibbulus (Giesbrecht)

Corycaeus gibbulus Giesbrecht, 1892, p. 675, taf. 51.

Corycaeus gibbulus Thompson and A. Scott, 1903, p. 286.

Corycaeus (Corycella) gibbulus M. Dahl, 1912, p. 115, taf. 15.

Corycella gibbula Farran, 1936, p. 139.

Corycaeus gibbulus Mori, 1937, p. 137, pl. 76, figs. 12-16, pl. 77, figs. 1-4.

Female. Length, 0.85-1.00 mm. Cephalothorax, 0.62-0.67 mm, abdomen, 0.27-0.30 mm. The species can be easily recognized by the peculiar form of genital segment.

Male. The male specimen of *C. gibbulus* and *C. concinnus* differ, as M. Dahl states, only in size. I follow Dahl's suggestion and decide the larger specimen (0.80-0.87 mm) as the male of *C. gibbulus*, and the small one (0.73-0.78 mm) as *C. concinnus*.

The species is very common in Japanese waters. It has a wide distribution in the warm regions of the Indian Ocean.

Corycaeus (Corycella) concinnus (Dana)

Corycaeus concinnus Giesbrecht, 1892, p. 675, taf. 51, figs. 21-24.

Corybaeus concinnus Thompson and A. Scott, 1903, p. 286.

Corycaeus concinnus A. Scott, 1909, p. 246.

Corycaeus (Corycella) concinnus M. Dahl, 1912, p. 121, taf. 15.

Corycella concinna Farran, 1936, p. 139.

Corycaeus concinnus Mori, 1937, p. 138, pl. 77, figs. 5-12.

Female. Length, 0.84-0.90 mm. The present specimen agrees quite well with Dahl's description.

The species is very common in Japanese waters. It is distributed in the subtropical region of the Indian and Pacific Oceans.

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Explanation of Plates

Plate 3.

Figs. 1—6. *Corycaeus (Corycaeus) speciosus* Dana

- Fig. 1. Female, dorsal view. $\times 30$
- Fig. 2. Female, abdomen, lateral view. $\times 60$
- Fig. 3. Female, 2nd antenna. $\times 120$
- Fig. 4. Female, 4th leg. $\times 120$
- Fig. 5. Male, dorsal view. $\times 30$
- Fig. 6. Male, 2nd antenna. $\times 120$

Figs. 7—11. *Corycaeus (Corycaeus) clausi* F. Dahl

- Fig. 7. Female, dorsal view. $\times 30$
- Fig. 8. Female, abdomen, lateral view. $\times 60$
- Fig. 9. Female, 2nd antenna. $\times 173$
- Fig. 10. Female, 4th leg. $\times 173$
- Fig. 11. Male, dorsal view. $\times 30$

Figs. 12—14. *Corycaeus (Corycaeus) crassiusculus* Dana

- Fig. 12. Female, dorsal view. $\times 30$
- Fig. 13. Female, abdomen, lateral view. $\times 60$
- Fig. 14. Female, 2nd antenna. $\times 120$
- Fig. 15. Male, dorsal view. $\times 30$

Plate 4.

Figs. 1—4. *Corycaeus (Corycaeus) viretus* Dana

- Fig. 1. Male, dorsal view. $\times 30$
- Fig. 2. Male, lateral view. $\times 30$
- Fig. 3. Male, 2nd antenna. $\times 120$
- Fig. 4. Male, 4th leg. $\times 173$

Figs. 5—8. *Corycaeus (Monocorycaeus) robustus* Giesbrecht

- Fig. 5. Female, dorsal view. $\times 26$
- Fig. 6. Female, abdomen, lateral view. $\times 30$
- Fig. 7. Female, 2nd antenna. $\times 90$
- Fig. 8. Female, 4th leg. $\times 120$

Figs. 9—15. *Corycaeus (Agetus) typicus* Kröyer

- Fig. 9. Female, dorsal view. $\times 30$
- Fig. 10. Female, lateral view. $\times 30$
- Fig. 11. Female, 2nd antenna. $\times 120$
- Fig. 12. Female, 4th leg. $\times 173$
- Fig. 13. Male, dorsal view. $\times 30$
- Fig. 14. Male, abdomen, lateral view. $\times 60$
- Fig. 15. Male, 2nd antenna. $\times 173$

Plate 5.

Figs. 1—7. *Corycaeus (Agetus) flaccuss* Giesbrecht

- Fig. 1. Female, lateral view. $\times 30$
- Fig. 2. Female, dorsal view. $\times 30$
- Fig. 3. Female, 2nd antenna. $\times 120$
- Fig. 4. Female, 4th leg. $\times 173$
- Fig. 5. Male, dorsal view. $\times 30$
- Fig. 6. Male, abdomen, lateral view. $\times 60$
- Fig. 7. Male, 2nd antenna. $\times 173$

Figs. 1—12. *Corycaeus (Agetus) limbatus* G. Brady

- Fig. 8. Female, dorsal view. $\times 30$
- Fig. 9. Female, lateral view. $\times 30$
- Fig. 10. Female, 2nd antenna. $\times 120$
- Fig. 11. Male, dorsal view. $\times 45$
- Fig. 12. Male, lateral view. $\times 45$

Figs. 13—16. *Corycaeus (Urocorycaeus) longistylis* Dana

- Fig. 13. Female, dorsal view. $\times 30$
- Fig. 14. Male, dorsal view. $\times 30$
- Fig. 15. Male, 2nd antenna. $\times 120$
- Fig. 16. Male, 4th leg. $\times 120$

Plate 6.

Figs. 1—12. *Corycaeus (Urocorycaeus) lautus* Dana

- Fig. 1. Male, dorsal view. $\times 26$
- Fig. 2. Male, 4th leg. $\times 120$

Figs. 3—6. *Corycaeus (Urocorycaeus) furcifer* Claus

- Fig. 3. Female, dorsal view. $\times 30$
- Fig. 4. Female, abdomen, lateral view. $\times 120$
- Fig. 5. Female, 2nd antenna. $\times 120$
- Fig. 6. Female, 4th leg. $\times 173$

Fig. 7—12. *Corycaeus (Ditrichocorycaeus) andrewsi* Farran

- Fig. 7. Female, dorsal view. $\times 45$
- Fig. 8. Female, abdomen, lateral view. $\times 120$
- Fig. 9. Female, 2nd antenna. $\times 173$
- Fig. 10. Male, dorsal view. $\times 60$
- Fig. 11. Male, abdomen, lateral view. $\times 120$
- Fig. 12. Male, 2nd antenna. $\times 240$

Figs. 13—19. *Corycaeus (Ditrichocorycaeus) asiaticus* F. Dahl

- Fig. 13. Female, dorsal view. $\times 35$
- Fig. 14. Female, abdomen, lateral view. $\times 70$
- Fig. 15. Female, 2nd antenna. $\times 100$
- Fig. 16. Female, apical spine of exopodite of 2nd leg. $\times 140$
- Fig. 17. Female, 4th leg. $\times 150$
- Fig. 18. Male, dorsal view. $\times 50$
- Fig. 19. Male, abdomen, lateral view. $\times 100$

Plate 7.

Figs. 1—4. *Corycaeus (Ditrichocorycaeus) subtilis* M. Dahl

- Fig. 1. Female, lateral view. $\times 60$
- Fig. 2. Female, abdomen, dorsal view. $\times 120$
- Fig. 3. Female, 2nd antenna. $\times 240$
- Fig. 4. Female, apical spine of exopodite of 2nd leg. $\times 240$

Figs. 5—13. *Corycaeus (Ditrichocorycaeus) dubius* Farran

- Fig. 5. Female, dorsal view. $\times 50$
- Fig. 6. Female, abdomen, lateral view. $\times 50$
- Fig. 7. Female, 2nd antenna. $\times 200$
- Fig. 8. Female, apical spine of exopodite of 2nd leg. $\times 200$
- Fig. 9. Female, 4th leg. $\times 200$
- Fig. 10. Male, dorsal view. $\times 60$
- Fig. 11. Male, abdomen, lateral view. $\times 120$
- Fig. 12. Male, 2nd antenna. $\times 240$
- Fig. 13. Male, apical spine of exopodite of 1st leg. $\times 240$

Figs. 14—17. *Corycaeus (Ditrichocorycaeus) dahli*, nom. nov.

- Fig. 14. Female, lateral view. $\times 50$
- Fig. 15. Female, abdomen, dorsal view. $\times 70$
- Fig. 16. Female, 2nd antenna. $\times 200$
- Fig. 17. Female, apical spine of exopodite of 2nd leg viewed in two different aspects. $\times 200$

Plate 8.

Figs. 1—5. *Corycaeus (Ditrichocorycaeus) dahli*, sp. nov.

- Fig. 1. Male, dorsal view. $\times 60$
- Fig. 2. Male, abdomen, lateral view. $\times 120$
- Fig. 3. Male, 2nd antenna. $\times 240$
- Fig. 4. Male, apical spine of exopodite of 2nd leg. $\times 240$

Figs. 6—15. *Corycaeus (Ditrichocorycaeus) affinis* McMurrich

- Fig. 6. Female, dorsal view. $\times 60$
- Fig. 7. Female, abdomen, lateral view. $\times 120$
- Fig. 8. Female, 2nd antenna. $\times 240$
- Fig. 9. Female, apical spine of exopodite of 2nd leg. $\times 200$
- Fig. 10. Female, 4th leg. $\times 240$
- Fig. 11. Male, dorsal view. $\times 60$
- Fig. 12. Male, abdomen, lateral view. $\times 120$
- Fig. 13. Male, 2nd antenna. $\times 240$
- Fig. 14. Male, apical spine of exopodite of 1st leg. $\times 240$
- Fig. 15. Male, 4th leg. $\times 40$

Figs. 16—18. *Corycaeus (Onychocorycaeus) agilis* Dana

- Fig. 16. Female, dorsal view. $\times 60$
- Fig. 17. Female, abdomen, lateral view. $\times 60$
- Fig. 18. Female, 4th leg. $\times 240$

Plate 9.

Figs. 1—5. *Corycaeus (Onychocorycaeus) agilis* Dana

- Fig. 1. Female, 2nd antenna. $\times 173$
- Fig. 2. Male, dorsal view. $\times 60$
- Fig. 3. Male, abdomen, lateral view. $\times 120$
- Fig. 4. Male, abdomen, other specimen, lateral view. $\times 120$
- Fig. 5. Male, 2nd antenna. $\times 240$

Figs. 6—12. *Corycaeus (Onychocorycaeus) catus* F. Dahl

- Fig. 6. Female, lateral view. $\times 45$
- Fig. 7. Female, abdomen, dorsal view. $\times 60$
- Fig. 8. Female, 2nd antenna. $\times 173$
- Fig. 9. Female, 4th leg. $\times 173$
- Fig. 10. Male, dorsal view. $\times 60$
- Fig. 11. Male, abdomen, lateral view. $\times 120$
- Fig. 12. Male, apical spine of exopodite of 2nd leg. $\times 200$

Figs. 13—20. *Corycaeus (Onychocorycaeus) pacificus* F. Dahl

- Fig. 13. Female, dorsal view. $\times 30$
- Fig. 14. Female, abdomen, lateral view. $\times 45$
- Fig. 15. Female, 2nd antenna. $\times 173$
- Fig. 16. Female, 4th leg. $\times 173$
- Fig. 17. Female, apical spine of exopodite of 2nd leg. $\times 200$
- Fig. 18. Male, abdomen, lateral view. $\times 60$
- Fig. 19. Male, 2nd antenna. $\times 120$

Plate 10.

Figs. 1—5. *Corycaeus (Corycella) rostratus* Claus

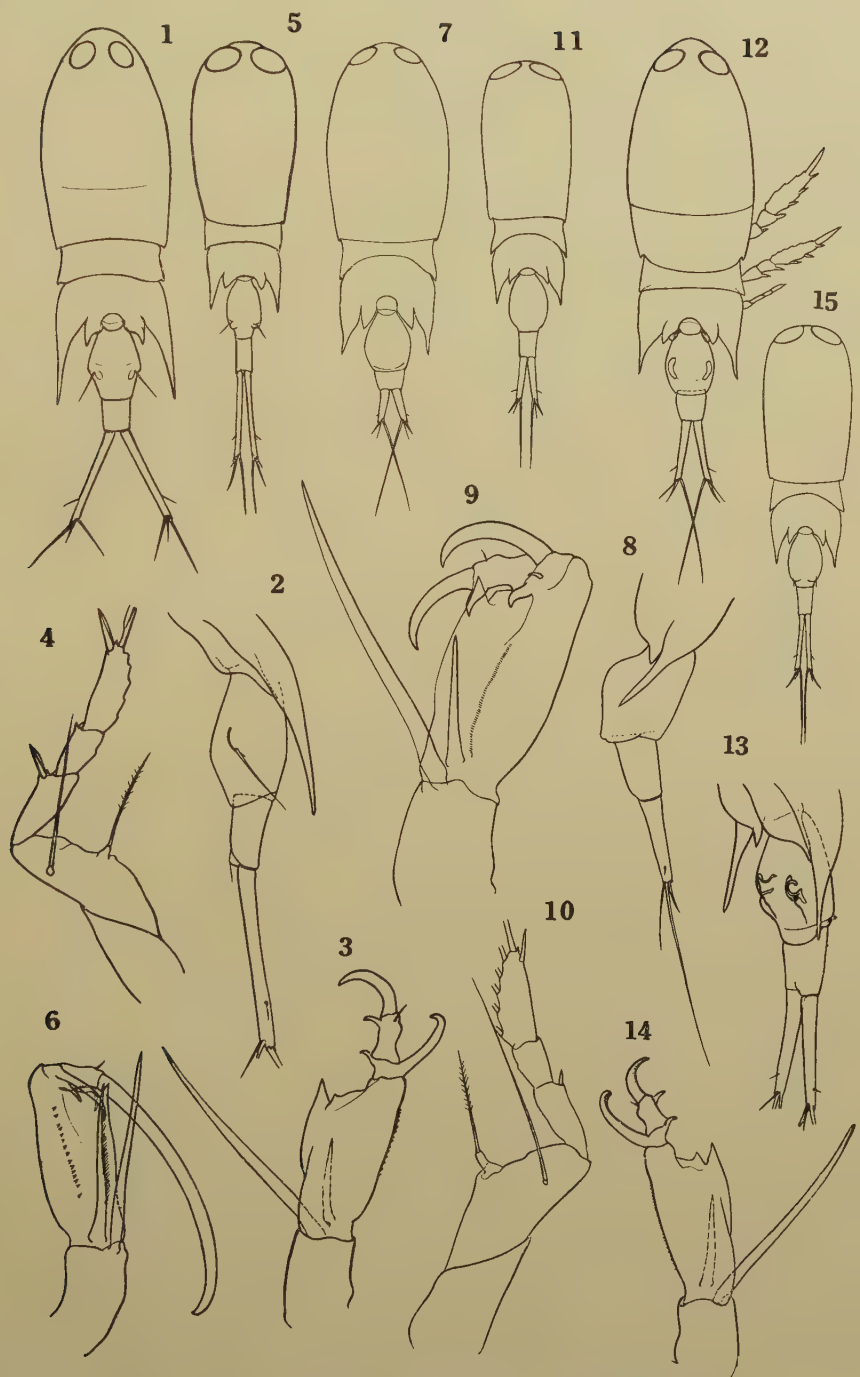
- Fig. 1. Male, lateral view. $\times 83$
- Fig. 2. Male, cephalothorax, dorsal view. $\times 120$
- Fig. 3. Male, abdomen, ventral view. $\times 120$
- Fig. 4. Male, 2nd antenna. $\times 240$
- Fig. 5. Male, 4th leg. $\times 353$

Figs. 6—11. *Corycaeus (Corycella) gibbulus* Giesbrecht

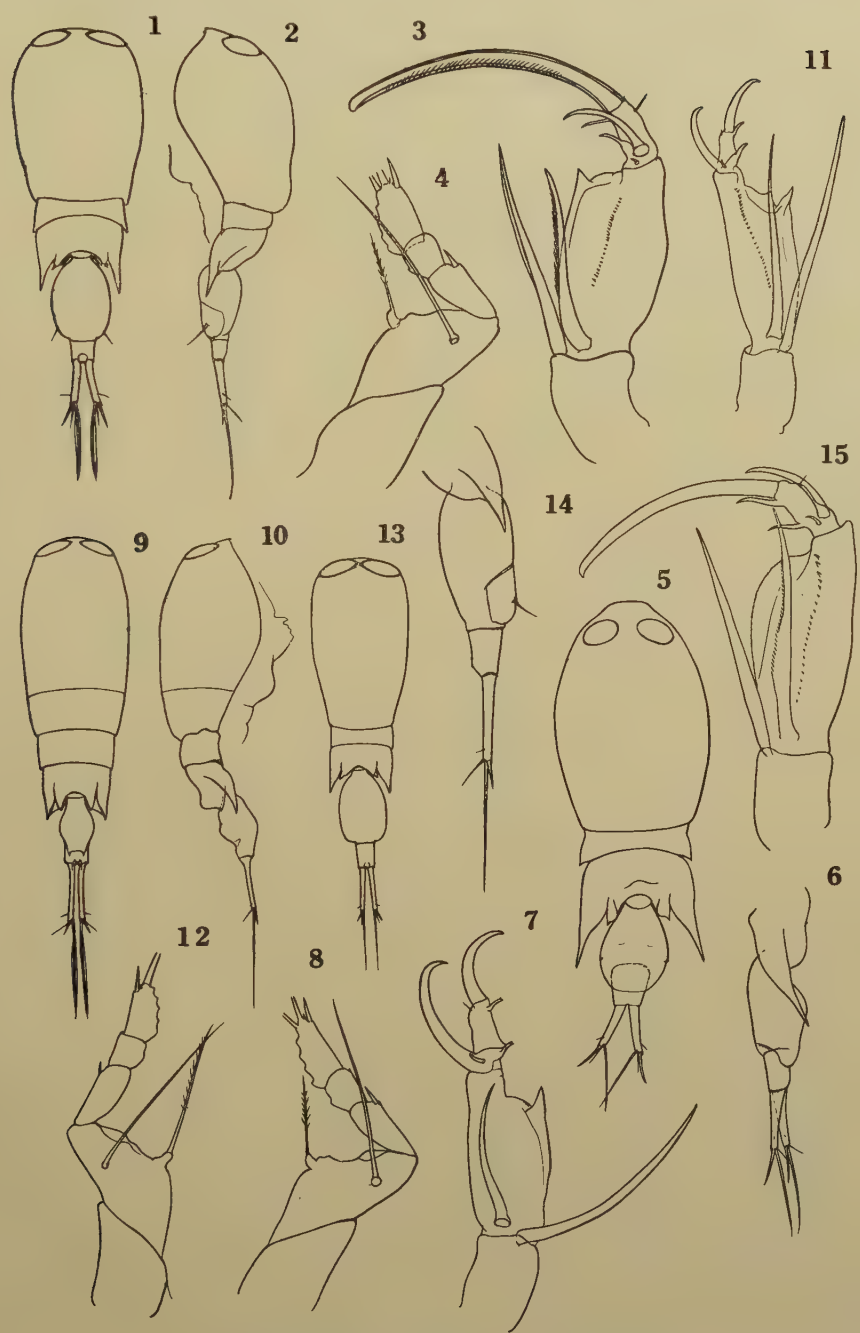
- Fig. 6. Female, lateral view. $\times 45$
- Fig. 7. Female, abdomen, ventral view. $\times 60$
- Fig. 8. Female, 2nd antenna. $\times 240$
- Fig. 9. Male, dorsal view. $\times 60$
- Fig. 10. Male, abdomen, lateral view. $\times 120$
- Fig. 11. Male, 2nd antenna. $\times 240$

Figs. 12—16. *Corycaeus (Corycella) concinnus* Dana

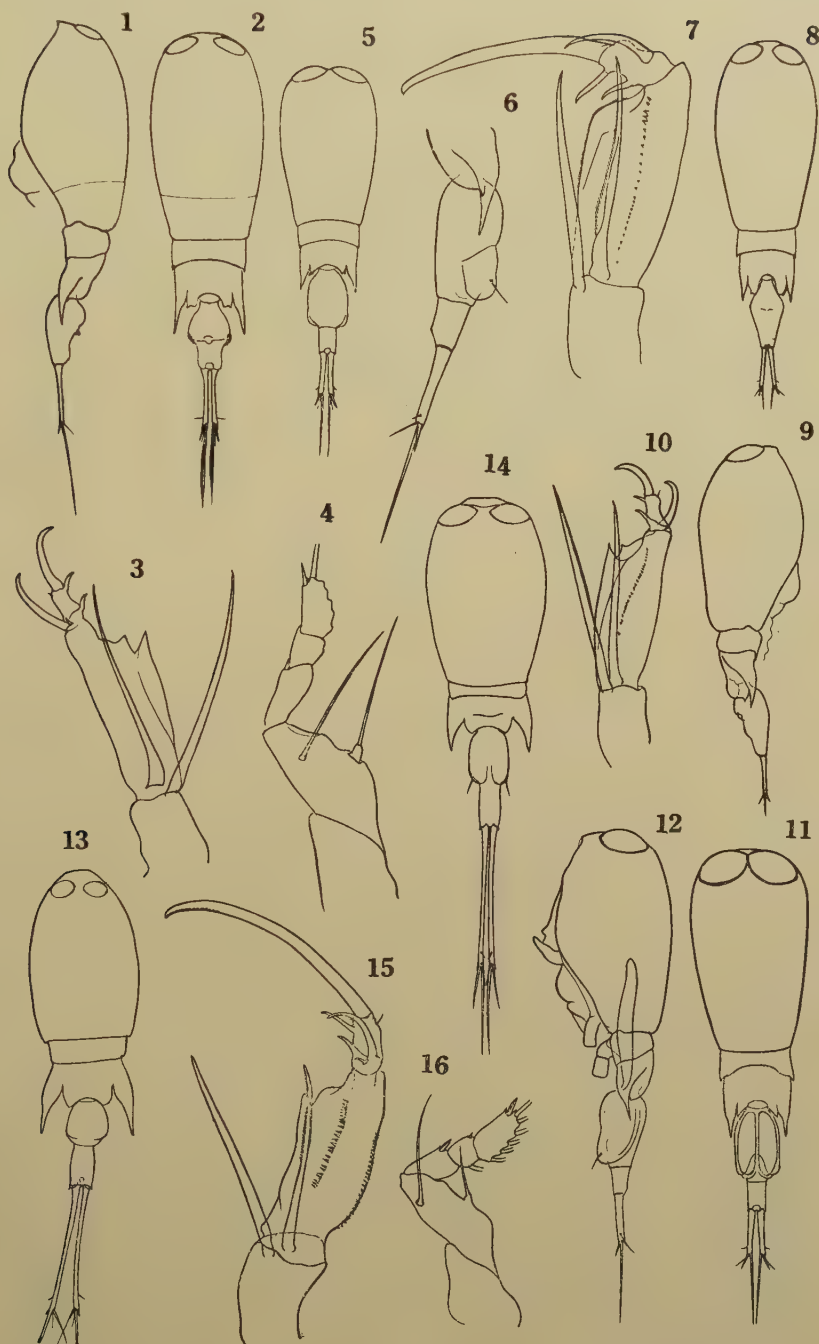
- Fig. 12. Female, dorsal view. $\times 60$
- Fig. 13. Female, lateral view. $\times 60$
- Fig. 14. Female, 2nd antenna. $\times 240$
- Fig. 15. Male, dorsal view. $\times 60$
- Fig. 16. Male, abdomen, lateral view. $\times 120$



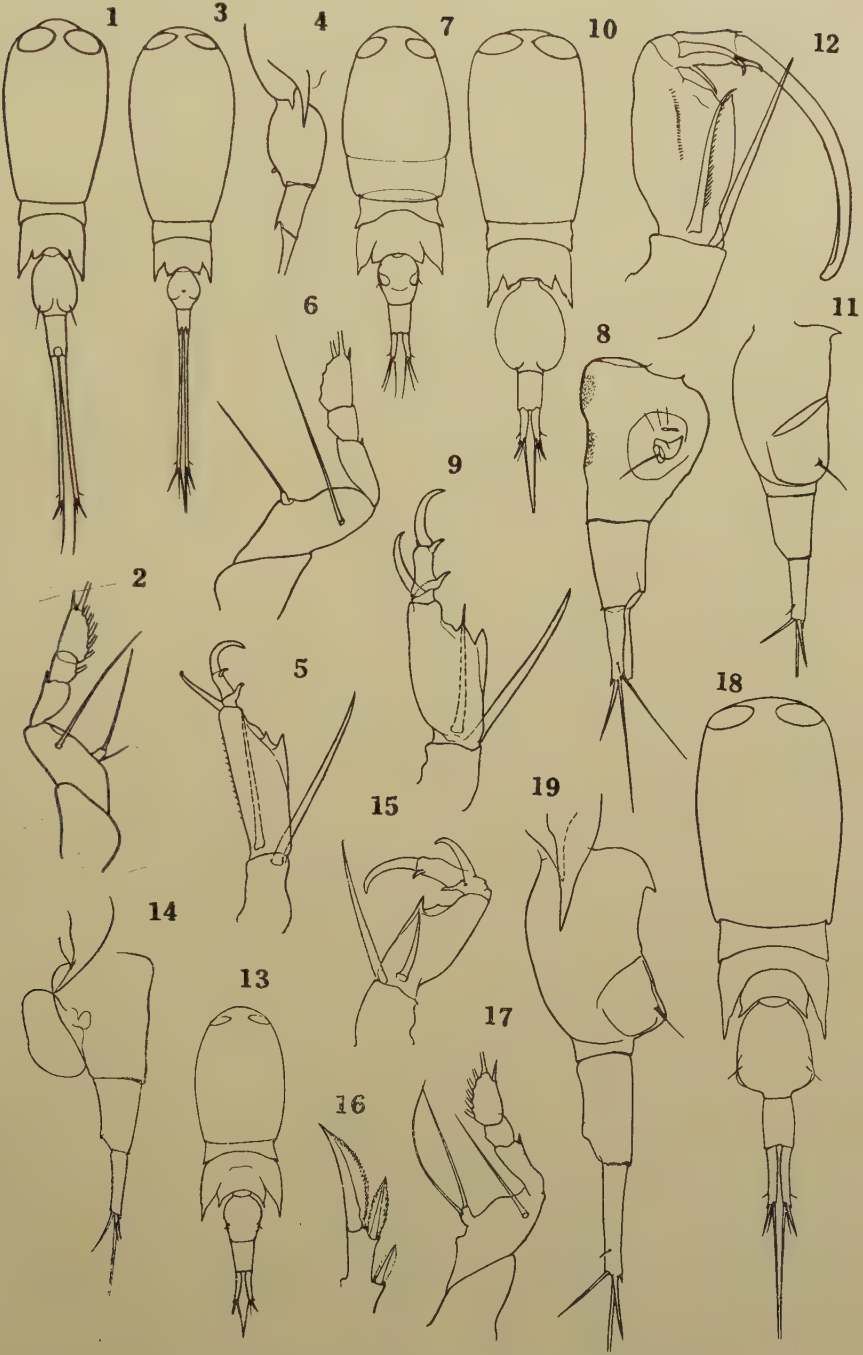
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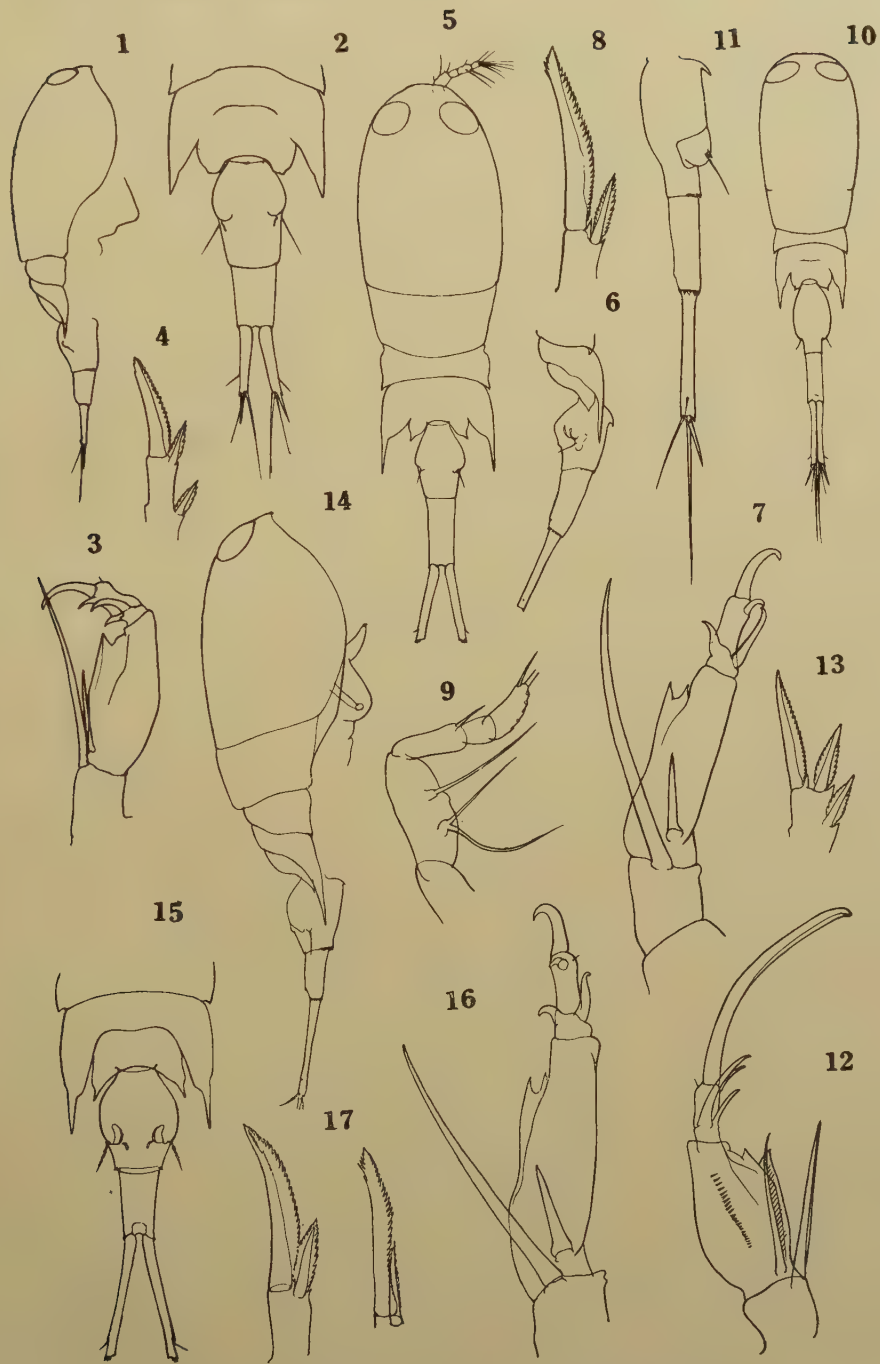
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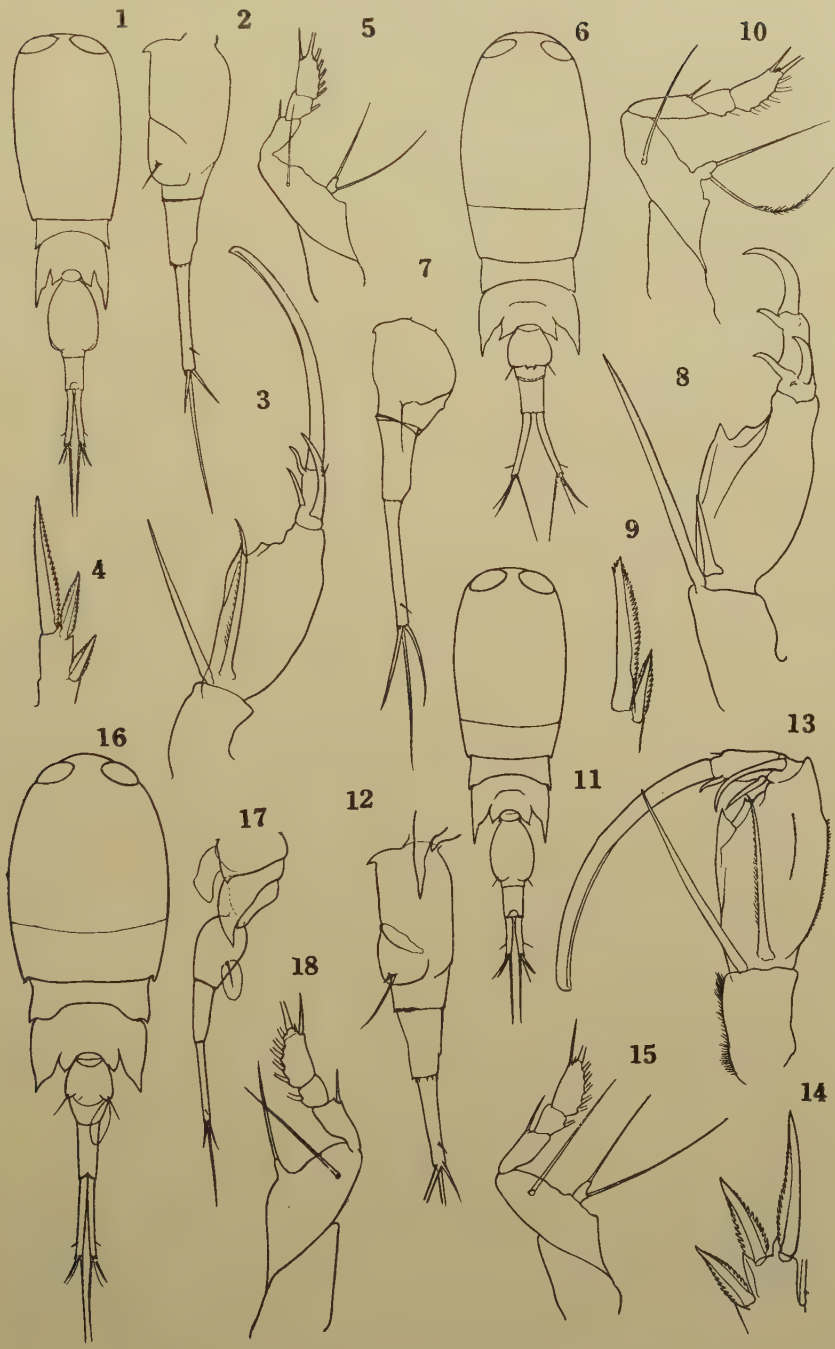
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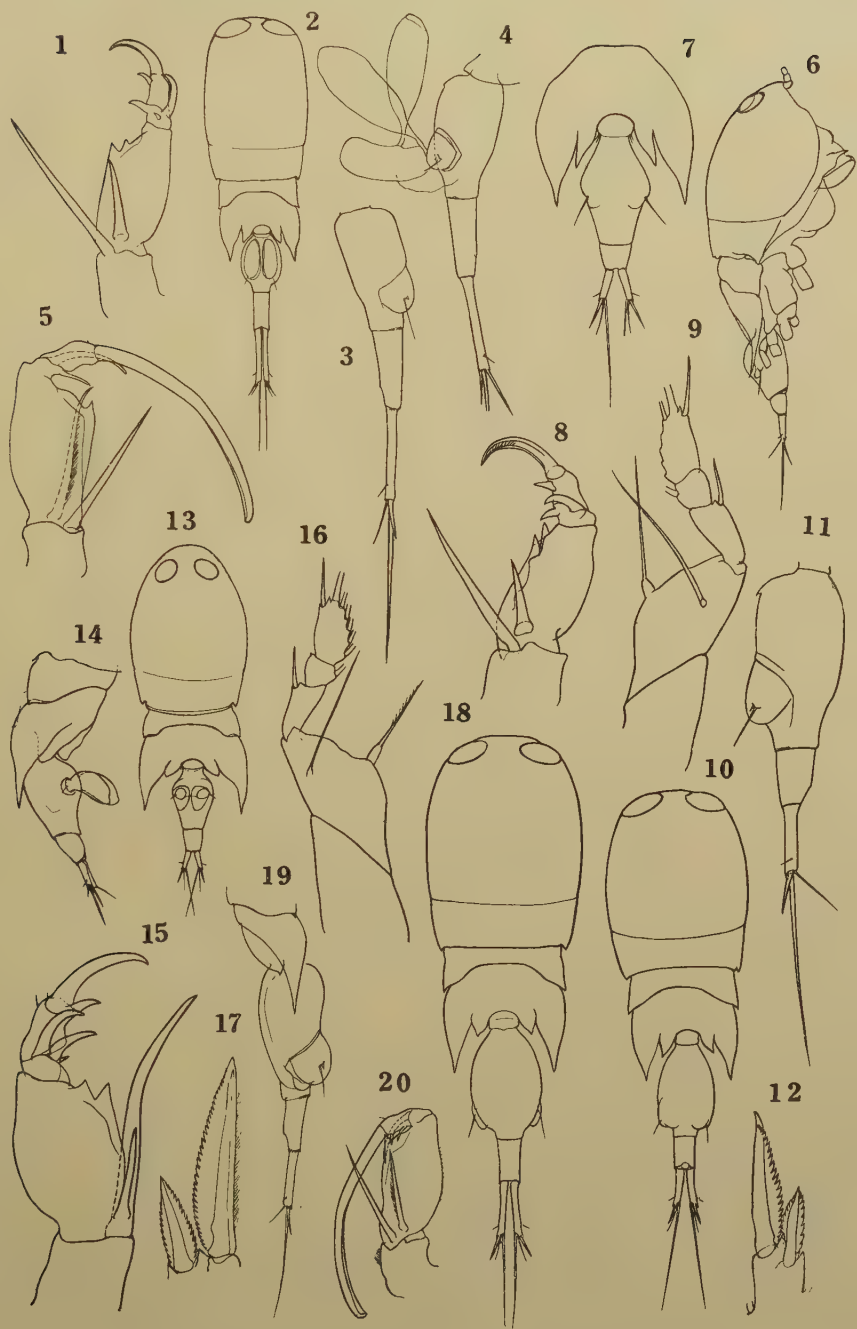
On Copepoda of the family Corycaeidae



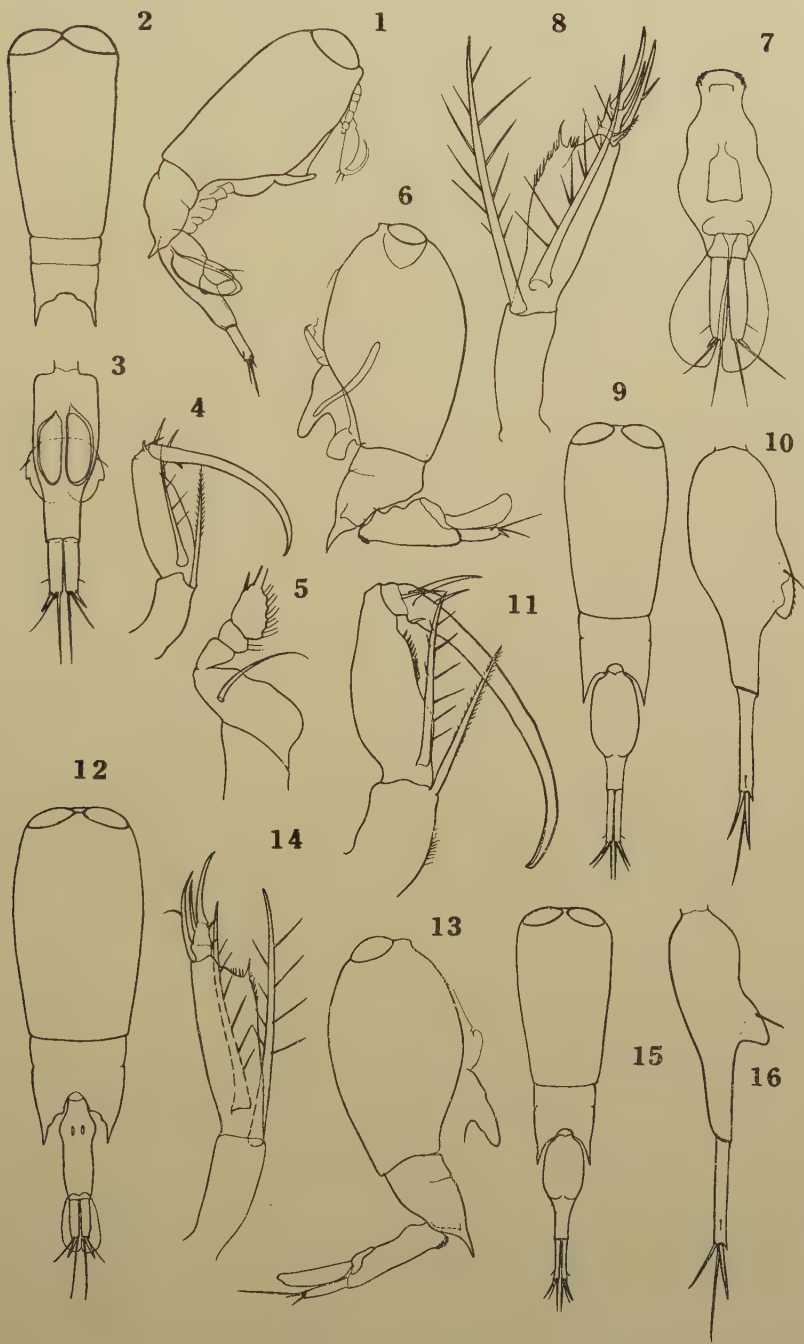
On Copepoda of the family Corycaeidae



On Copepoda of the family Corycaeidae



On Copepoda of the family Corycaeidae



On Copepoda of the family Corycaeidae

THE PELAGIC COPEPODS OF THE IZU REGION, MIDDLE JAPAN
SYSTEMATIC ACCOUNT III.
FAMILY AETIDEIDAE (PART 1)

OTOHIKO TANAKA

Fisheries Department, Faculty of Agriculture, Kyushu University

With 18 Text-figures

Family AETIDEIDAE

Genus *Aetideus* BRADY, 1883

Up to the present time four species of this genus have been recorded: *Aetideus armatus* (BOECK), *A. giesbrechti* (CLEVE), *A. bradyi* A. SCOTT, and *A. acutus* FARRAN. The genus has the following characters: head and first thoracic segment are fused, and so are the fourth with the fifth; lateral corners of last thoracic segment produced into an acute spine on each side; abdomen 4-jointed in female; first antenna 23-jointed, joints 8 and 9, joints 24 and 25 are fused; second antenna with endopodite about as long as exopodite; mandible has exopodite longer than endopodite; maxillae and maxillipede are of usual type; first leg with 3-jointed exopodite and 1-jointed endopodite, outer marginal spine only on second and third joints of exopodite; second leg with 3-jointed exopodite and endopodite; third and fourth leg with 3-jointed exopodite and endopodite; fifth leg absent in female. Male resembles female in general appearance, differing from it in the absence of rostral spine, in the number of abdominal segment, and in the structure of fifth pair of legs.

G. O. SARS divided the genus in two; *Aetideus* and *Euaetideus* on the ground that the shape of rostral spine is different; to the latter genus belong *A. giesbrechti*, *A. bradyi*, and *A. acutus*.

Aetideus armatus (BOECK)

(Fig. 23, *a-i*)

Aetideus armatus SARS, 1903, p. 25; ESTERLY, 1905, p. 154; A. SCOTT, 1909, p. 37; WOLFENDEN, 1911, p. 209; WITH, 1915, p. 75; SARS, 1925, p. 41; FARRAN, 1926, p. 246; FARRAN, 1929, p. 228; SEWELL, 1929, p. 99; WILSON, 1932, p. 45; JESPERSEN, 1934, p. 52; FARRAN, 1936, p. 87; MORI, 1937, p. 38; WILSON, 1950, p. 159; BRODSKY, 1950, p. 143.

Female. Length, 1.82 mm: cephalothorax, 1.43 mm; abdomen, 0.39 mm. In dorsal view cephalothorax moderately robust; frontal margin of head rounded, and has no median crest (fig. *a*). In lateral aspect, head is boldly arched (fig. *b*); rostrum consists of two rather slender spines, and has a knob at the middle of the base. Last thoracic segment ends in two acute spines which are more slender than those figured by previous authors.

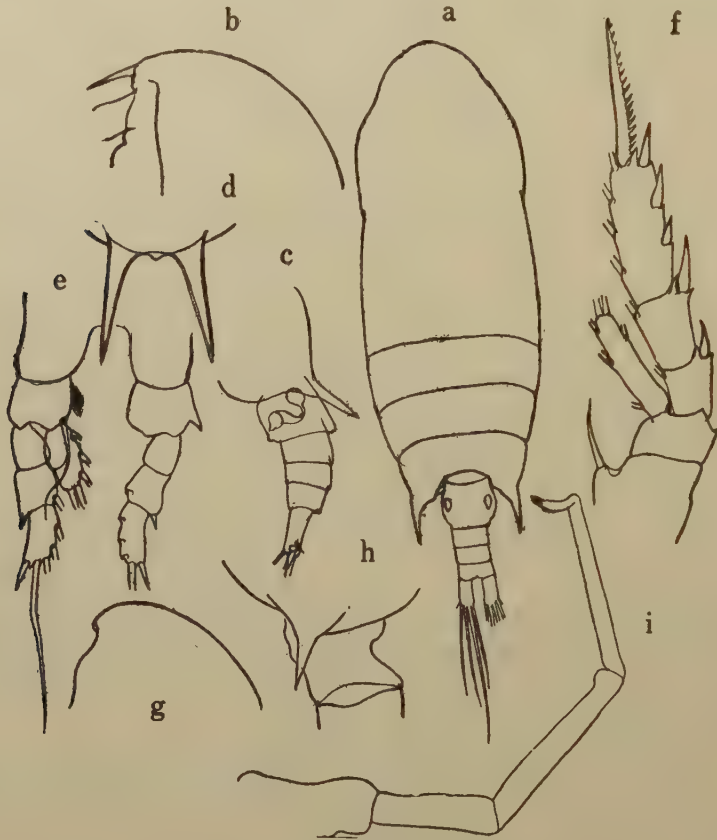


Fig. 23. *Aetideus armatus* (BOECK).

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, rostrum; *e*, 1st leg; *f*, 2nd leg; *g*, Male: head, lateral aspect; *h*, last thoracic segment, lateral aspect; *i*, 5th pair of legs.

Abdominal segments and furca are in the proportional lengths 35:16:14:12:23 =100; genital segment wider than long; furcal rami 2-times as long as wide.

First antenna 23-jointed, extends to distal end of furca; joint 23 is as long as the 22nd; in A. SCOTT's figure joint 23 is shorter than the 22nd. Second antenna has exopodite about as long as endopodite. Mandible has a slender second basal joint.

First maxilla has 9 setae on outer lobe, 11 setae on exopodite, 6+3+4 setae on endopodite, 5 setae on second basal joint. Second maxilla and maxillipede as figured by previous authors.

First leg has 3-jointed exopodite and 1-jointed endopodite; in the present specimen mounted right leg is of abnormal structure; second basal joint has an outer-edge spine as shown in the figure (fig. *e*). Second leg has 3-jointed exopodite and 1-jointed endopodite; outer edge spine of second exopodite exceeds base of proximal spine of third joint; terminal spine of exopodite has 17 teeth (fig. *f*). Third and fourth legs have each 3-jointed exopodite and endopodite; terminal spine of exopodite of third leg has 17 teeth; that of fourth leg has 13 teeth on the left and 15 on the right leg.

Male. Length, 1.80 mm: cephalothorax, 1.32 mm; abdomen, 0.48 mm. In dorsal view male has general resemblance to female; but lateral spines of last thoracic segment shorter. Rostrum much reduced, and represented by only a small knob. Abdomen 5-segmented, segments and furca in proportional lengths 16:23:23:21:2:15=100; anal segment very short and almost concealed beneath the preceding; furcal rami about 2-times as long as wide.

First antenna reaches back to middle of third abdominal segment; joints with following proportional lengths:

Joint	1	2	3	4	5	6	7	8-9-10	11	12-13	14	15	16	17
	27	45	25	24	24	27	30	66	27	57	33	45	54	57
	18	19	20-21	22	23	24	25							
	57	72	117	60	75	69	9=1000;							

joints 3, 9 and 14 have each a long seta; proximal joints have each well developed aesthetascs. Second antenna with exopodite about 1.2-times as long as endopodite.

Swimming legs as in female; end-spine of exopodite of second leg has 26 teeth, and that of third leg has 26 teeth. Right fifth leg rudimentary; left leg slender; distal joint short, and furnished with hairs along inner margin; apex of the joint carries four small spines (fig. *i*).

Occurrence. One adult female and male from Sagami in July, and one male from Suruga, December 1937, from the depth 1000 m to the surface.

Distribution. It is widely distributed in the North Atlantic, Pacific, Indian, Malayan and Chinese seas, also in the Great Barrier Reef region.

Aetideus giesbrechti (CLEVE)

Aetideus armatus GIESBRECHT, 1892, p. 213; *Aetideus giesbrechti* A. SCOTT, 1909, p. 36; WOLFENDEN, 1911, p. 209; *Euaetideus giesbrechti* G. O. SARS, 1925, p. 42; *Aetideus giesbrechti* FARRAN, 1926, p. 247; FARRAN, 1929, p. 228; FARRAN, 1936, p. 87; MORI, 1937, p. 38, pl. 16.

Female. Length, 1.98 mm: cephalothorax, 1.59 mm; abdomen, 0.39 mm.

Remarks. *A. giesbrechti* is distinguished from *A. acutus* by the shape of head

and lower crest. The "Siboga" specimen measured 2.1 mm in female; FARRAN's specimen from New Zealand, 1.92-1.98 mm. The specimen from Izu has longer furca. WOLFENDEN's specimen is not evenly rounded on the frontal margin of the head.

Occurrence. One adult female from the surface layer of Sagami Bay, in December 1935.

Distribution. It has been recorded from the Indian Ocean, Malay Archipelago and Gulf of Guinea. The species appears to be a warm-water inhabitant.

Aetideus bradyi A. SCOTT

(Fig. 24, *a-i*)

Aetideus bradyi A. SCOTT, 1909, p. 38, pl. 5.

Female. Length, 1.46 mm: cephalothorax, 1.14 mm; abdomen, 0.32 mm. In dorsal view frontal margin of head is constricted by the base of rostrum (fig. *a.*). In lateral view crest well marked; forehead is highly chitinised (fig. *b.*). Rostrum short and strong, with divergent points; knob-like processes of inner side of the wide base are observed in trace (fig. *d.*). Wing-like processes of last thoracic segment reach back to distal margin of second abdominal segment (fig. *c.*).

Proportional lengths of abdominal segments and furca: 35:18:12:15:20=100. Furcal rami two times as long as wide; appendicular seta long (fig. *e.*).

First antenna reaches back to distal margin of fourth abdominal segment; proportional lengths of joints are:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	28	35	21	21	24	24	26	45	21	24	28	31	42	45	52	56
	18	19	20	21	22	23	24	25								
	59	66	59	54	73	75	76	14=1000.								

Mouth parts and swimming legs have no interesting features; the number of teeth on terminal spine of exopodite of second and third legs are 15 and 13 respectively.

Male. Length, 1.40 mm: cephalothorax 1.10 mm; 0.39 mm. The specimen resembles male of *A. armatus* (fig. *f.*). Forehead slightly chitinised. Rostrum is represented by a small knob-like projection when viewed from the lateral (fig. *h.*). Lateral corners of last thoracic segment produced on each side into a strong spine with a basal thickening (fig. *g.*).

Abdomen 5-segmented, segments and furca in proportional lengths 19:22:19:19:4:17=100. Furcal rami 1.7 times as long as wide.

First antenna 25-jointed, reaches back to distal margin of second abdominal segment; joints are in the following proportional lengths:

Joint	1	2	3	4	5	6	7	8-9-10	11	12-13	14	15	16	17
	28	33	20	20	24	24	28	65	24	61	37	45	57	61
	18	19	20-21	22	23	24	25							
	61	69	107	73	77	77	8=1000;							

these proportional lengths are quite different from those of *A. armatus*. Second antenna with exopodite about 1.1-times as long as endopodite. Outer lobe of first maxilla has 5 long setae; exopodite with 10 setae. Maxillipede has first and second basal joints and endopodite in following proportional lengths 30:30:16.

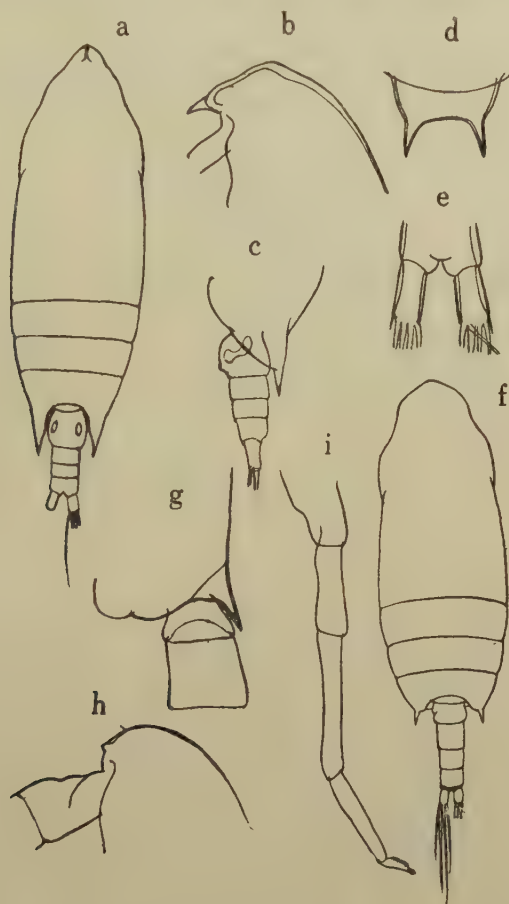


Fig. 24. *Aetideus bradyi* A. SCOTT.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, rostrum; *e*, anal segment and furca; *f*, Male: dorsal aspect; *g*, last thoracic segment, lateral aspect; *h*, head, lateral aspect; *i*, 5th pair of legs.

Swimming legs do not show any specific character. Number of teeth on terminal spine of exopodite of second to fourth legs are 20, 19, and 16 respectively. In fifth pair of legs right one is reduced; left one is long and slender as in *A. armatus* (fig. *i*).

Remarks. The present male specimen can be distinguished from *A. armatus* in the followings: much smaller size; proportional lengths of abdominal segments, and

joints of 1st antenna. Immature male specimen, measured 1.36 mm, has left fifth leg composed of three joints; right leg reduced. Shape of head resembles that of the adult female.

Occurrence. One adult female from the surface layer of Sagami in winter 1935 and an adult female and an immature male in a vertical hauls from the depth 1260 m to the surface in Suruga Bay, Dec. 1937,

Distribution. The species has been recorded only from the Malayan region. The species appears to be distributed in the warm regions of the Indo-Pacific.

Aetideus acutus FARRAN

(Fig. 25, *a-g*)

Aetideus acutus FARRAN, 1929, p. 228, fig. 5; FARRAN, 1936, p. 87.

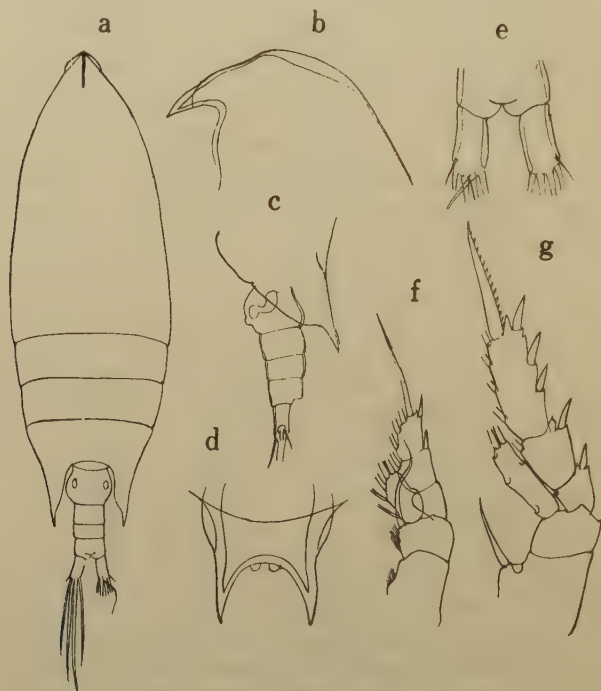


Fig. 25. *Aetideus acutus* FARRAN.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, rostrum; *e*, anal segment and furca; *f*, 1st leg; *g*, 2nd leg.

Female. Length, 1.66 mm. Abdomen is contained 3.6-times in the length of cephalothorax. In dorsal view head contracts gradually to a blunt point and the frontal margin is constricted by wide base of rostrum (fig. *a*). In lateral view frontal margin of head has a well-marked chitinous crest which is slightly raised at the apex,

but it is not so strongly arched as described and figured by Farran (fig. *b*). Rostrum is large and strongly chitinised with points directing rather straight, and has two knobs at its base (fig. *d*). Last thoracic segment well chitinised, and produced into strong points reaching to the middle of third abdominal segment (fig. *c*).

Proportional lengths of abdominal segments and furca are 34:18:13:13:22=100; the segments and furca well chitinised. Furcal rami 2 times as long as wide (fig. *d*). Mouth parts as those of *Aetideus giesbrechti*.

First antenna exceeds slightly distal end of furca; the joints are in proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	30	57	21	21	24	24	27	45	20	24	24	33	38	45	54	57
	18	19	20	21	22	23	24	25								
	57	63	57	54	68	71	74	15=1000.								

Number of serration on terminal spine of exopodite of second to fourth legs are 15, 16 and 14 respectively. First and second legs as shown in the figures (fig. *f*, *g*).

Remarks. The species comes very near to *A. giesbrechti*, but differs from it in the shape of forehead both in dorsal and lateral aspects, in the proportional lengths of abdominal segments and furca, and also in the proportional lengths of joints of first antenna. The crest in lateral view is less prominent than that of *A. bradyi*.

Occurrence. The species is rather common both in the surface and deep waters.

Distribution. The species has been recorded from New Zealand and the Great Barrier Reef.

Genus *Aetideopsis* G. O. SARS, 1903

From the Malayan region only one species of this genus has, up to the present time, been reported: *Aetideopsis multiserrata* (WOLFENDEN) (= *Aetideopsis rostrata* A. SCOTT). I have found in the collection the same species and other two species which appear to be yet undescribed. The genus differs from *Aetideus* in the following: head and first thoracic segment completely or incompletely fused; last thoracic segment separates from the fourth; first antenna 24-jointed, joints 8 and 9 are fused; mouth parts as in *Aetideus*; first leg has an outer edge-spine on first joint of exopodite; first basal joint is furnished with spinules on the outer margin, and bristles on the inner margin; second leg has 2-jointed endopodite, first basal joint is furnished with groups of spinules on the outer proximal margin. Fifth leg absent in female. Male resembles female in general appearance; fifth pair of legs are of about equal lengths on each side with three free joints of exopodite attached to the 2-jointed basals; the endopodite rudimentary.

Aetideopsis multiserrata (WOLFENDEN)

(Fig. 26, *a-m*)

Faroella multiserrata WOLFENDEN, 1904, p. 117; FARRAN, 1908, p. 29; *Aetideopsis rostrata* A. SCOTT, 1909, p. 81; *Chiridius nasutus* WITH, 1915, p. 81; *Aetideopsis multiserrata* SARS, 1925, p. 43; *Chiridius multiserrata* FARRAN, 1926, p. 248; *Aetideopsis multiserrata* JESPERSEN, 1934, p. 53; BRODSKY, 1950, p. 146.

Female. Length, 3.13 mm: cephalothorax, 2.38 mm; abdomen, 0.75 mm; so abdomen is contained about 3.2-times in length of cephalothorax. Body slender; the greatest width is about one-third the length of cephalothorax. Last two thoracic segments are separate. Lateral corners of last thoracic segment produced into a strong spine on each side, reaching the middle of genital segment (fig. *a, b*). Rostrum highly chitinated and very prominent. The shape in lateral view differs somewhat from the figure given by Sars or A. Scott; it directs anteriorly, hollowing at base; external margin of rostrum are not so concave, as figured by A. Scott (fig. *f*).

Abdomen 4-segmented, segments and furca are in proportional lengths, 35:24:17:10:14=100. Genital segment produced moderately below (fig. *c*). Furcal rami about as long as wide; furcal setae slender (fig. *e*).

First antenna reaches back to distal margin of second abdominal segment; proportional lengths of joints are as follows:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	35	63	29	24	29	29	31	59	29	29	29	31	38	42	45	45
	18	19	20	21	22	23	24	25								
	45	66	70	45	38	66	63	20=1000;								

posterior seta of 23rd joint extends beyond distal margin of the 25th. Second antenna with exopodite about 1.3-times as long as endopodite. Mandible shows no characteristic features. Outer lobe of 1st maxilla with 8 setae, exopodite with 10 setae. Second maxilla and maxillipede as figured by A. Scott.

First leg has 3-jointed exopodite and 1-jointed endopodite; joints of exopodite are broad; first basal joint carries a group of spinules on the outer margin about middle (fig. *g*). Terminal spine of second to fourth legs have 40, 36, and 40 teeth respectively. Second leg as shown in the figure.

Male. Length, 3.04 mm: cephalothorax, 2.25 mm; abdomen, 0.79 mm. Head fused with first thoracic segment (fig. *j*). Line of fusion between fourth and fifth thoracic segments scarcely visible in dorsal aspect (fig. *i*). Base of lateral process of last thoracic segment moderately inflated (fig. *l*). Branches of rostrum closely set together.

Abdomen 5-segmented, segments and furca in proportional length 16:34:23:16:1:10=100. Furcal rami 1.4-times as long as wide. Second to fourth segments are fringed with fine teeth on the distal margin.

First antenna extends to distal end of second thoracic segment; joints are in proportional lengths:

Joint	1	2	3	4	5	6	7	8-9-10	11	12	13	14	15	16	17
	42	61	28	28	33	33	38	113	38	38	38	38	42	42	39
	19	20	21	22	23	24	25								
	42	52	52	52	52	46	14=1000.								

Second antenna with exopodite little longer than endopodite; first basal joint has rows of hairs on the posterior surface. Mandible not characteristic. In first maxilla first

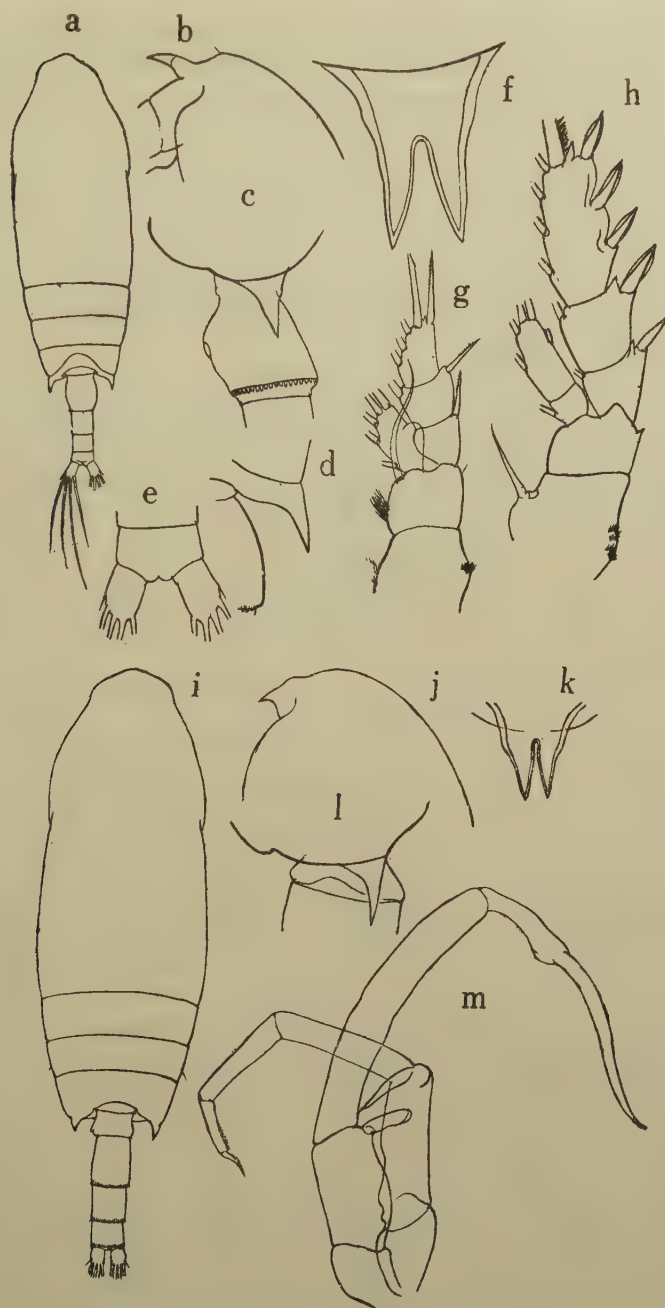


Fig. 26. *Aetideopsis multiserrata* WOLFENDEN.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and genital segment, lateral aspect; *d*, last thoracic segment, dorsal aspect; *e*, anal segment and furca, dorsal aspect; *f*, rostrum; *g*, 1st leg; *h*, 2nd leg; *i*, Male: dorsal aspect; *j*, head, lateral aspect; *k*, rostrum; *l*, last thoracic segment, lateral aspect; *m*, 5th pair of legs.

outer lobe has 6 long and 3 short setae, and a rounded swelling on outer margin when viewed in posterior aspect; spinulation of various parts as follows: exopodite, 9 setae; endopodite, 11 setae; second basal joint, 4 setae; third inner lobe, 3 setae; first and second inner lobe have each rudimentary sensory setae. Maxillipede has a slender second basal joint.

In first leg outer-edge spine of joints of exopodite rather short when compared with those of adult female or immature male. Second leg with 2-jointed endopodite; terminal spine of exopodite with 40 teeth; first basal joint with fine spinules on the outer margin. Third and fourth legs broken off. Fifth pair of legs resemble those of *Aetideopsis minor* WOLFENDEN (fig. *m*).

Remarks. Shape of rostrum, lateral process of last thoracic segment, and proportional lengths of joints of first antenna distinguish the present specimen from *Aetideopsis minor* WOLFENDEN. VERVOORT (1950) described a new species, *Aetideopsis trichechus*. He is convinced that his species is identical with *A. rostrata* A. SCOTT. But his specimen differs from the latter in the shape of rostrum, and in the proportional lengths of outer-edge spine of joints of exopodite of first leg.

Occurrence. Three adult females and one male from Suruga, July 1937; fourty three females and three males from Sagami, November 1937, from the depth 1000 m to the surface.

Distribution. Recorded from the North Atlantic and Malayan region.

Aetideopsis divergens sp. nov.

(Fig. 27, *a-j*)

Female. Length, 3.01 mm; cephalothorax, 2.35 mm; abdomen, 0.66 mm; so abdomen is contained 3.5-times in the length of cephalothorax. Cephalothorax about 2.6-times as long as it is wide at first thoracic segment. Posterior spines of last thoracic segment wider but shorter when compared with those of the preceding species. Articular membrane between head and first thoracic segment is observed both in dorsal and lateral aspects. Integuments finely granulated (fig. *a, b, c*). Rostrum stout, bifurcate and strongly divergent (fig. *d*).

Abdomen 4-segmented, segments and furca with proportional lengths 38:19:16:11:16=100. Genital segment about as long as wide. Furcal rami little longer than wide (6:5), and slightly divergent.

First antenna 24-jointed, extends to distal margin of third abdominal segment: joints with following proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	34	60	24	30	27	27	30	60	27	27	27	37	37	47	47	50
	18	19	20	21	22	23	24	25								
	43	63	70	43	53	63	63	20=1000.								

Second antenna with exopodite about 1.3-times as long as endopodite. Mandible, maxilla, and maxillipede as those of *A. rostrata* Sars.

In first leg outer edge spines of exopodite long and slender (fig. *e*). Joints of endopodite of second leg are incompletely separate; articular membrane clearly seen on the posterior surface. Terminal spines of second to fourth legs have 58, 45, and 40 teeth respectively; the teeth are partially fused on its basal part by a sort of lamella.

Male. length, 3.13 mm: cephalothorax, 2.25 mm; abdomen 0.98 mm. Body oblong ovate. Cephalothorax 2.5-times as long as it is wide at first thoracic segment. Head

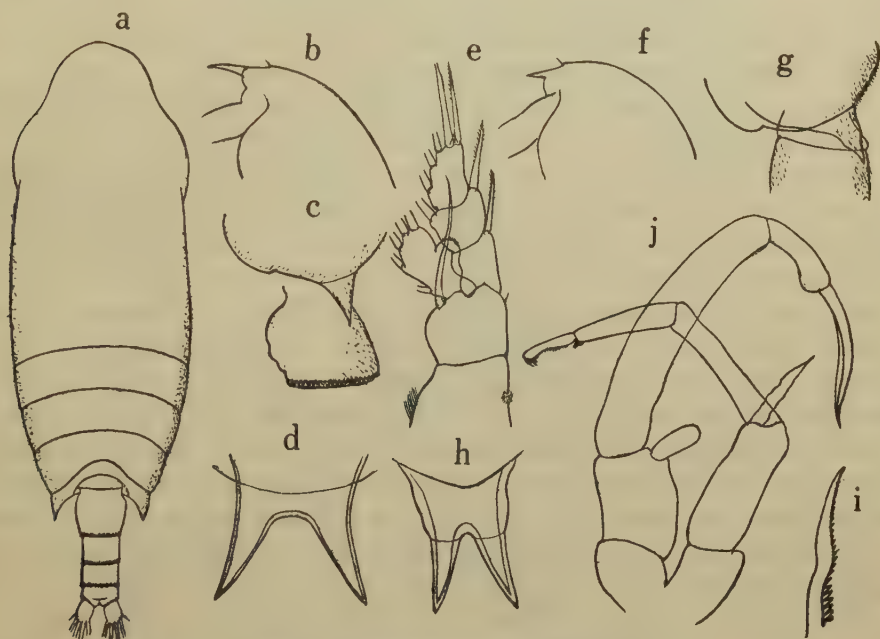


Fig. 27. *Aetideopsis divergens* sp. nov.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and genital segment, lateral aspect; *d*, rostrum; *e*, 1st leg; *f*, Male: head, lateral aspect; *g*, last thoracic segment, lateral aspect; *h*, rostrum; *i*, terminal spine of exopodite of 2nd leg; *j*, 5th pair of legs.

and first thoracic segment completely fused; fourth and fifth thoracic segments are partially fused; the line of fusion faintly visible in dorsal aspect, thoracic segments finely granulated (fig. *f*, *g*). Rostrum divergent, pointing forwards (fig. *h*).

Abdomen 5-segmented, proportional lengths of segments and furca are 12:31:25:18:2:12=100. Anal segment concealed beneath the foregoing. Furcal rami about as long as wide.

First antenna reaches back to distal margin of second thoracic segment; proportional lengths of joints as follows:

Joint	1	2	3	4	5	6	7	8-9-10	11	12	13	14	15	16	17
	40	70	30	30	34	34	34	104	34	30	35	35	40	40	40
	18	19	20	21	22	23	24	25							
	45	60	60	45	50	50	45	15=1000.							

Second antenna strong; exopodite about as long as endopodite. Mandible and second maxilla reduced. Maxillipede with long basal joints; fourth joint of endopodite produced anteriorly.

In first leg outer edge spine of exopodite rather short; inner margin of second basal joint smooth. Second leg with 48 teeth on the terminal spine of exopodite; the terminal spine is deformed as shown in the figure (fig. *i*). Third leg missing. Fourth leg has 42 teeth on terminal spine of exopodite. Fifth pair of legs as in *Chiridius armatus* (BOECK); endopodite rudimentary (fig. *j*).

Immature male measured 2.7 mm. First antenna extends to distal margin of third abdominal segment. First leg resembles that of the adult female.

Remarks. The specimens agree with *Aetideopsis minor* WOLFENDEN, except for divergent rostrum and somewhat short furca. *A. minor* has the furca which is about 2-times as long as wide; FARRAN's specimen of the same species (2.92-3.25 mm) from the Antarctic has furcal rami 1.5-times as long as wide. Endopodite of second leg is, according to WOLFENDEN, 3-jointed, but it is 2-jointed in FARRAN's specimen. *A. minor* WOLFENDEN (*Chiridius minor* FARRAN) has been recorded only from the Antarctic. The present specimens were collected in the vertical hauls 1000-800 m, 1000-600 m, 200-0 m, and 100-0 m. It is unreasonable that the Antarctic species has so wide a distribution in the upper layers of the North Pacific. Shape of rostrum and structure of furcal rami are different from those of the Antarctic specimen. The present specimen differs from either of *A. pacifica* and *A. divaricata* described by ESTERLY.

Occurrence. Six adult females and one male in all from deep waters of both Sagami and Suraga.

Aetideopsis cristata sp. nov.

(Fig. 28, *a-m*)

Female. Length, 3.84 mm; cephalothorax, 2.94 mm; abdomen, 0.90 mm; so abdomen is contained 3.26-times in length of cephalothorax. Head with chitinised median crest, separates from 1st thoracic segment. Last two thoracic segments separate; last thoracic segment produced posteriorly into spines which extend to more than two-thirds of genital segment. Integument finely granulated (fig. *a, b, c*). Rostrum very strong, with a wide base; rami straight and parallel (fig. *d*).

Abdomen 4-segmented, segments and furca with proportional lengths: 25:23:19:14:19=1000. Genital segment produced below. Furcal rami 1.3-times as long as wide.

First antenna extends to distal margin of 3rd abdominal segment; proportional lengths of joints as follows:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	41	60	24	24	28	28	28	58	24	24	24	36	39	45	47	50
	18	19	20	21	22	23	24	25								
	45	61	69	45	53	66	64	16=1000.								

Fig. 28. *Aetideopsis cristata* sp. nov.

a, Female: dorsal aspect; b, head, lateral aspect; c, last thoracic segment and genital segment, lateral aspect; d, rostrum; e, 2nd maxilla; f, 1st leg; g, 2nd leg; h, Male: head, lateral aspect; i, last thoracic segment; lateral aspect; j, last thoracic segment, dorsal aspect; k, rostrum; l, 1st maxilla; m, 5th pair of legs.

Second antenna with exopodite about 1.2-times as long as endopodite. First maxilla with 7 long and 2 short setae on first outer lobe; second outer lobe without seta; exopodite with 10 setae; second basal with 5 setae; endopodite with 4+3+6 setae; first inner lobe with 14 setae; second inner lobe with 5 setae; third lobe with 4 setae. Second maxilla and maxilliped as those of the preceding species (fig. *e*).

In first leg outer edge spine of first and second joints of exopodite short, not reaching the middle of the next (fig. *f*). Second leg has articular membrane between first and second joints on anterior surface of endopodite (fig. *g*). Terminal spine of exopodite of second to fourth legs have 27, 32 and 40 teeth respectively.

Male. Length, 3.25 mm; cephalothorax 2.55 mm; abdomen, 0.97 mm; so abdomen is contained 2.7-times in length of cephalothorax. Head and first thoracic segment completely fused; fourth and fifth thoracic segments incompletely articulated. Posterior margin of last thoracic segment produced into spines extending to distal margin of first abdominal segment (fig. *h*). Integument finely granulated. Rostrum strong, slightly divergent, and has a wide base (fig. *k*).

Abdominal segments and furca with proportional lengths 12:30:24:19:2:13 =100; second to fourth segments are fringed with fine teeth on the distal margin. Furcal rami 1.4-times as long as wide.

First antenna extends to distal margin of second thoracic segment; proportional lengths of joints are as follows:

Joint	1	2	3	4	5	6	7	8-9-10	11	12	13	14	15	16	17
	54	54	31	31	31	36	36	72	31	32	41	36	45	45	45
	18	19	20	21	22	23	24	25							
	45	58	58	45	49	58	54	13=1000;							

joints 9 and 10 are fused on the posterior margin. Second antenna with exopodite about as long as endopodite. Mandible with a rounded second basal joint; exopodite about as long as endopodite. Maxilla with 9 setae on outer lobe; 9 setae on exopodite (fig. *l*). Second maxilla much reduced. Second basal joint of maxilliped a little longer than first.

First to fourth swimming legs as in the female. Terminal spine of exopodite of second to fourth legs with 31, 34 and 36 teeth respectively.

Fifth pair of legs as those of *Chiridius armatus* (BOECK) figured by Sars (fig. *m*).

Remarks. The present specimen differs from the other member of the genus in the followings: shape of rostrum; forehead with median crest; short outer edge spine of first and second joints of exopodite of first leg.

Occurrence. 118 females and 4 males from Sagami in the vertical hauls from the depth 1000 m to the surface, Nov. 1937.

Genus *Undinopsis* G. O. Sars, 1884

(*Bradyidius* GIESBRECHT)

The genus comprises, at present three species, *Undinopsis bradyi* Sars (= *Bradyidius armatus* GIESBRECHT), *U. tropicus* WOLFENDEN and *U. stimilis* Sars. A single specimen belonging to the genus was found in the collection, which appears to be different from those hitherto been described. The generic characters are as follows: head fused with first thoracic segment; fourth and fifth thoracic segments are fused; rostrum terminates into strong bifurcate points; last thoracic segment ends in acute expansions; abdomen of female 4-jointed; first antenna 24-jointed; mouth parts as those of *Aetideus*; first leg with 3-jointed exopodite and 1-jointed endopodite; joints of exopodite bears each an outer edge spine; second leg with 3-jointed exopodite and 2-jointed endopodite; third and fourth legs with 3-jointed exopodite and endopodite; endopodite of second to fourth legs are furnished with groups of minute spinules. Fifth leg absent in female. Sars recorded the occurrence of *Undinopsis bradyi* from the Norwegian Sea. WOLFENDEN, A. SCOTT, and FARRAN recorded the tropical species *U. tropicus* WOLFENDEN from the Maldives Archipelago, Malay Archipelago and Great Barrier Reef area respectively. From Japanese waters MORI reported *U. bradyi* under the name *Bradyidius armatus* (BRADY). It is said that *U. bradyi* and *U. tropicus* differ only in size and in minute points of structure.

Undinopsis angustus sp. nov.

(Fig. 29, a-i)

Male. Length, 1.37 mm; cephalothorax, 1.03 mm; abdomen, 0.34 mm; so abdomen is contained 3-times in the length of cephalothorax. Cephalothorax moderately robust; the greatest width less than half the length of cephalothorax. Head fused with first thoracic segment, so are the fourth with the fifth (fig. a). Posterior margin of last thoracic segment produced into acute spines extending beyond distal margin of first abdominal segment (fig. c). Rostrum strong, curved somewhat posteriorly at the apex (fig. b).

Abdomen 5-segmented, segments and furca with proportional length 14:32:19:19:3:13=100; second to fourth segments are fringed with fine teeth on the distal margin. Furcal rami 1.3-times as long as wide.

First antenna extends to distal margin of second abdominal segment; joints are in the following proportional length:

Joint	1	2	3	4	5	6	7	8-9-10	11	12-13	14	15	16	17
	24	36	20	20	24	28	32	82	28	73	41	49	49	53
	18	19	20	21	22	23	24	25						
	56	65	61	56	65	65	61	12=100;						

joints 20 and 21 are fused on the right. Second antenna with exopodite about as long as endopodite (fig. e). Second maxilla much reduced. Maxillipede has a large second joint of endopodite.

First leg has on first joint of exopodite a short outer edge spine; third joint of exopodite has also a short outer edge spine; first basal joint with fine spinules on the outer margin (fig. *f*). Second leg has 2-jointed endopodite; second joint of endopodite has three groups of spinules on the posterior surface; terminal spine of the exopodite has 24 teeth on the left, 22 teeth on the right (fig. *g*). Third and fourth legs with 3-jointed endopodite; second and third joints of endopodite are

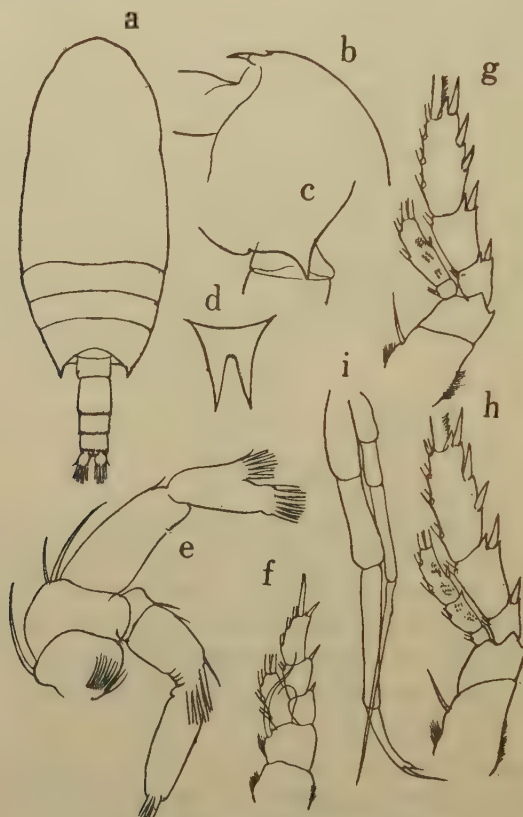


Fig. 29. *Undinopsis angustus* sp. nov.

a, Male: dorsal aspect; *b* head, lateral aspect; *c*, last thoracic segment, lateral aspect; *d*, rostrum; *e*, 2nd antenna; *f*, 1st leg; *g*, 2nd leg; *h*, 4th leg; *i*, 5th pair of legs.

furnished with groups of minute spinules on posterior surface (fig. *h*); terminal spine of exopodite of third leg with 25 teeth, and that of fourth with 27 teeth.

Fifth pair of legs resemble those of male of the genus *Chiridius* (fig. *i*).

Remarks. The tropical specimen of *Undinopsis*, taken in the "Siboga", measured 1.7 mm, the specimen from the Maldives, 1.2 mm, and that from the Great Barrier Reef region, 1.5–1.63 (female) and 1.26–1.28 (male) mm. The Maldivian specimen for which

WOLFENDEN proposed *U. tropicus*, differs from the northern species only in size and in the number of teeth on terminal spine of exopodite of second to fourth legs. MORI reported the occurrence of a female of *U. bradyi* from the neighbouring waters of Japan. His specimen is not identical with *U. bradyi*; the specimen has the thoracic spines not reaching the middle of genital segment; in first leg outer marginal spine of first joint of exopodite wanting; the specimen appears to be a member of *Gaidius*. The present specimen is close, in size, to the tropical specimen of *Bradyidius armatus* recorded by A. SCOTT, or to *Unidinopsis tropicus* recorded by WOLFENDEN and by FARRAN. If *U. bradyi*, the northern species, would have been distinct from *U. tropicus*, the tropical species, only in having coarse teeth on terminal spine of exopodite of second to fourth legs, the present specimen is not identical with *U. bradyi*, in having the male fifth legs differ from those of *U. bradyi* figured by SARS. FARRAN described the male of *U. tropicus* only on size without giving any figures. I propose to give to the present specimen a new name *U. angustus*.

Occurrence. One male from Sagami and two males from Suraga in the vertical hauls from the depth 1000 m to the surface, 1937.

Genus *Chiridius* GIESBRECHT, 1892

The following species have been recorded from various regions of the oceans: *Chiridius gracilis* FARRAN, *Ch. poppei* GIESBRECHT, *Ch. obtusifrons* SARS, *Ch. modestus* WITH, *Ch. polaris* WOLFENDEN, *Ch. minor* WOLFENDEN, *Ch. antarcticus* (WOLFENDEN) and *Ch. armatus* (BOECK). The genus has, according to GIESBRECHT's original description, the following characters: general appearance as in *Aetideus*, but rostrum absent; endopodite of second antenna about half the length of exopodite; endopodite of mandible very short. According to his definition the following five species are comprised in *Chiridius* in its restricted sense: *Ch. gracilis*, *Ch. poppei*, *Ch. obtusifrons*, *Ch. modestus* and *Ch. polaris*. FARRAN included both rostrate and arostrate species in the same genus *Chiridius* from the reason that presence or absence of rostrum does not seem to be sufficient to separate generically the species which, in other respects, resemble closely each other. He added *Chiridius armatus* (BOECK), *Faroella minor* WOLFENDEN (= *Aetideopsis minor* (WOLFENDEN)) and *Faroella antarcticus* WOLFENDEN (= *Aetideopsis antarcticus* WOLFENDEN) into *Chiridius*. Here the genus *Chiridius* in wide sense comprises four genera, namely *Chiridius* GIESBRECHT, *Unidinopsis* SARS, *Aetideopsis* SARS and *Faroella* WOLFENDEN. They resemble, indeed, each other in the structure of swimming legs, viz. first leg with 3-jointed exopodite and 1-jointed endopodite, and joints of exopodite have each an outer edge spine; second leg with 3-jointed exopodite and 2-jointed endopodite, though there are some exception in incomplete segmentation of joints of endopodite; third and fourth legs with 3-jointed exopodite and endopodite. Then, why does FARRAN not included

Undinopsis Sars in his wide-sensed *Chiridius*? The genus *Undinopsis* differs from the members of *Chiridius* only in the armature on the posterior surface of joints of endopodite of second to fourth legs. GIESBRECHT defined as generic characters of *Chiridius*, beside the absence of rostrum, short endopodite of second antenna and mandible. In *Aetideopsis* and, perhaps, *Faroella*, endopodite of mandible is not small at all; in *Chiridius* Sars (*Pseudoaetideus* WOLFENDEN) endopodite of second antenna is about half the length of exopodite. These three genera, *Aetideopsis*, *Faroella* and *Chiridius* GIESBRECHT resemble each other in general appearance and in the structure of swimming legs with exception of the structure of second antenna and mandible. Absence or presence of rostrum is, by no means, insufficient reason of separating generically species. FARRAN himself distinguishes arostrate and rostrate species in his wide-sensed *Chiridius*. It seems reasonable, for the present, to follow GIESBRECHT's definition of the genus *Chiridius*.

In the present collection five species have been detected of which two have been described, and the remaining three undescribed. Male specimens of this genus resemble so closely each other, differing only in size and in minute points of structure, that it is troublesome to connect them to the corresponding females.

Chiridius gracilis FARRAN

(Fig. 30, *a-e*)

Chiridius gracilis FARRAN, 1908, p. 30; A. SCOTT, 1909, p. 42; WOLFENDEN, 1911, p. ; WITH, 1915, p. 75; FARRAN, 1929, p. 229; FARRAN, 1936, p. 87; TANAKA, 1937, p. 225, fig. 6.

Female. Length, 2.55 mm. Posterior spines of last thoracic segment not divergent. In some specimens thoracic spines show a slight basal thickening, as figured by FARRAN (1929). Endopodite of second leg has a trace of segmentation between first and second joints on the anterior surface. Terminal spine of exopodite of fourth leg has 22 teeth. My previous specimen (1937) had 24, 28 and 26 teeth on the terminal spine of exopodite of second to fourth legs respectively. Fifth leg absent in female.

Male. Length, 2.32 mm: cephalothorax, 1.68 mm; abdomen, 0.64 mm. Cephalothorax oblong ovate, the greatest width 0.65 mm (fig. *a*). Lateral spines of last thoracic segment stout, with a wide base; last two thoracic segments completely fused (fig. *c*). Rostrum is represented by a thin triangular plate.

Abdomen 4-segmented, segments and furca with proportional lengths 18:26:25:17:2:12=100; furcal rami about 1.3-times as long as wide. Second to fourth segments are fringed with fine teeth on the distal margin.

First antenna 23-jointed, extends to distal margin of last thoracic segment; joints are in the proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16
	35	45	23	23	26	26	29	63	29	29	35	35	35	45	45
	17	18	19	20	21	22	23	24-25							
	52	52	59	63	46	60	60	75	=1000.						

Second antenna with exopodite about 1.4-times as long as endopodite; first basal joint with a row of hairs on the posterior surface. Mandible with short endopodite. First maxilla with 5 setae on outer lobe; 9 setae on exopodite; 9 setae on endopodite;

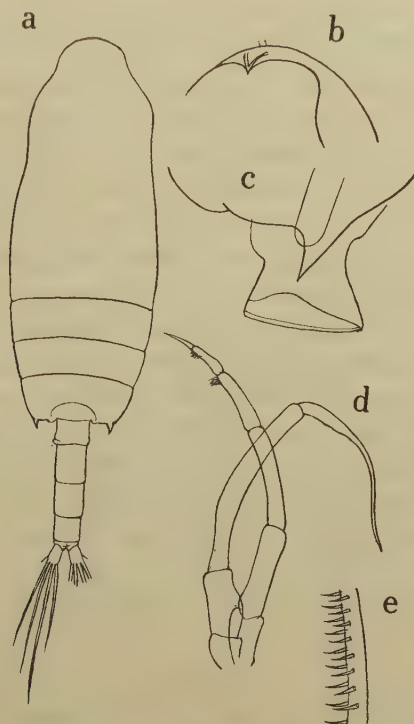


Fig. 30. *Chiridius gracilis* FARRAN.

a, Male: dorsal aspect; b, head, anterior aspect; c, last thoracic segment, lateral aspect; d, 5th pair of legs.

first inner lobe with aesthetasque-like filaments. Maxillipede slender; fifth joint of endopodite with a characteristic setae, as shown in the figure (fig. e).

First leg with 3-jointed exopodite. Second leg with 2-jointed endopodite; terminal spine of exopodite has 28 teeth. Third and fourth legs with 3-jointed endopodite; terminal spines of exopodite of the same legs with 30 and 28 teeth respectively. Fifth pair of legs slender, resemble those of *Ch. obtusifrons* SARRS; right leg about as long as second swimming leg; left leg short, about four-fifths the length of right leg.

Occurrence. Eight females from Suruga, July, 1937, 35 females and two males from Sagami, Nov. 1937, from deep waters.

Distribution. The species is widely distributed in the deep waters of the Pacific, Atlantic, Indian, Malay Archipelago.

Chiridius poppei GIESBRECHT

(Fig. 31, *a-f*)

Chiridius poppei GIESBRECHT, 1892, p. 224, t. 14, 36; A. SCOTT, 1909, p. 41; FARRAN, 1929, p. 229; JESPERSEN, 1934, p. 55; TANAKA, 1937, p. 254; BRODSKY, 1950, p. 152.

Female. Length, 1.83–1.87 mm. Terminal spine of exopodite of second and third legs slightly longer than third joint of exopodite of the corresponding legs. Serration of terminal spines are straight and rather coarse. Fifth leg absent in female.

Male. Length, 1.52 mm; cephalothorax 1.11 mm; abdomen, 0.41 mm. Abdomen is contained 2.7-times in the length of cephalothorax. Cephalothorax robust; oral part of head much dilated in dorsal view. Head fused with first thoracic segment, and so are the fourth with the fifth (fig. *a*). Last thoracic segment produced into a small spine on each side; the spine is slender and convergent, bent posteriorly in the right angle to the ventral margin of last thoracic segment (fig. *d*). Rostrum short and one-pointed, rounded at the apex, directing downwards; in lateral view rostrum looks like beak; there is no trace of median crest (fig. *b*).

Abdomen 5-segmented, and furca with proportional lengths 20:26:20:18:2:14 = 100. Anal segment very short, concealed beneath the foregoing. Furcal rami 1.4-times as long as wide; furcal seta longer than the combined lengths of abdominal segments and furca.

First antenna 23-jointed, reaches back to distal end of second abdominal segment; proportional lengths of the joints:

Joint	1	2	3	4	5	6	7	8-9-10	11	12	13	14	15	16	17
	38	26	19	19	23	23	23	72	30	30	34	37	45	49	57
	18	19	20	21	22	23	24	25							
	60	72	76	53	64	68	64	19=1000.							

Second antenna with exopodite 1.4-times as long as endopodite; posterior surface of first basal joint bears rows of bristles. Mandible with a very strong seta on inner proximal margin of second basal joint. First maxilla with 7 setae on outer lobe, 9 setae on exopodite, 9 setae on endopodite. Second maxilla reduced. Maxillipede with second basal joint 1.25-times as long as the first basal; two proximal setae on anterior margin of second basal are fine and short.

First leg with a very short outer edge spine on first joint of exopodite (fig. *e*). In second leg articular membrane between first and second joints of endopodite is observed on the anterior surface; terminal spine of exopodite has 27 teeth. Third

leg has 3-jointed endopodite; terminal spine of exopodite with 25 teeth. Fourth leg slender; terminal spine of exopodite has 20 teeth.

In fifth pair of legs terminal joint of right leg is long and slender; left leg as long as the combined lengths of terminal spine and three joints of exopodite of fourth leg taken together (fig. *f*).

Remarks. In the male specimen small lateral spines of last thoracic segment, long fifth legs and coarse teeth on terminal spine of exopodite of second to fourth legs distinguish the species from the foregoing.

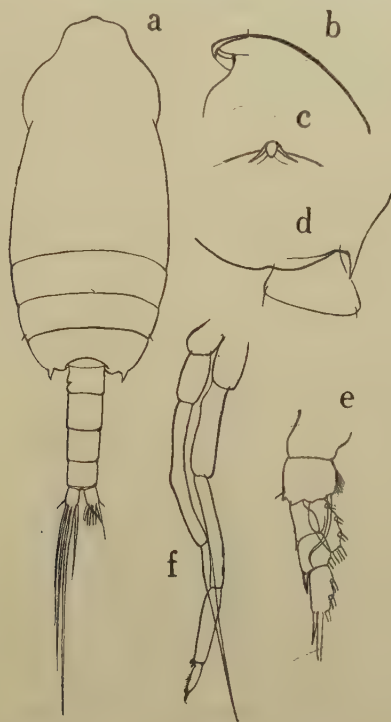


Fig. 31. *Chiridius poppei* GIESBRECHT.

a, Male: dorsal aspect; *b*, head, lateral aspect; *c*, rostrum; anterior aspect; *d*, last thoracic segment, lateral aspect; *e*, 1st leg; *f*, 5th pair of legs.

Occurrence. 16 females and one male from Sagami, and 20 females from Suruga, 1937; one male in a vertical haul from the depth 400-200 m in Suruga, Nov. 1938.

Chiridius longispinus sp. nov.

(Fig. 33, *a-h*)

Male. Length, 1.52 mm: cephalothorax, 1.14 mm; abdomen, 0.38 mm. Abdomen

is contained 3-times in the length of cephalothorax. Head fused with first thoracic segment. Line of fusion between fourth and fifth thoracic segments slightly visible from the dorsal (fig. *a*). Last thoracic segment is produced into acute spines, extending beyond the end of first abdominal segment; the spines are longer and wider in proportion than in the male of *Ch. poppei* (fig. *d*). Rostrum one-pointed, beak-like in lateral view; base of rostrum well-marked in anterior aspect (fig. *b*, *c*).

Abdomen 5-segmented, segments and furca with proportional lengths 16:26:21:19:2:16=100. Furcal rami about 1.4-times as long as wide. Distal margin of second to fourth segments are fringed with fine teeth.

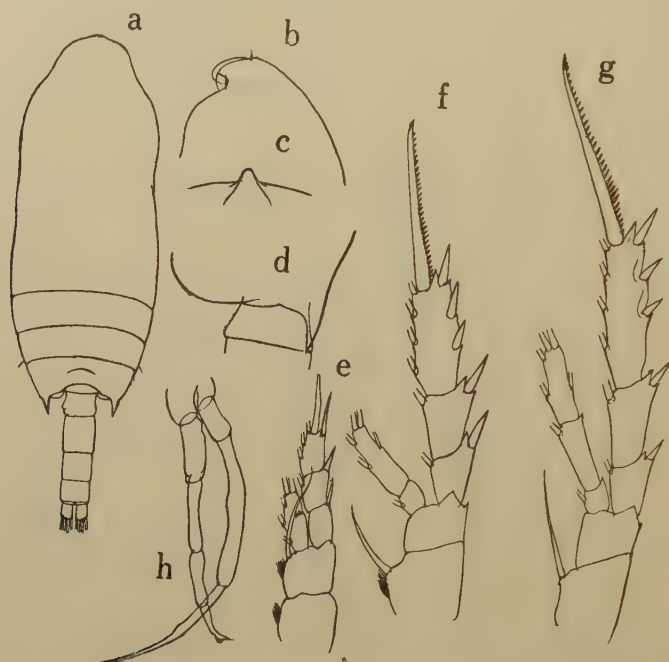


Fig. 32. *Chiridius longispinus* sp. nov.

a, Male: dorsal aspect; *b*, head, lateral aspect; *c*, rostrum, antero-dorsal aspect; *d*, last thoracic segment, lateral aspect; *e*, 1st leg; *f*, 2nd leg; *g*, 4th leg; *h*, 5th pair of legs.

Terminal joints of first antenna broken off; the remaining 18 joints with proportional lengths:

Joint	1	2	3	4	5	6	7	8-9-10	11	12	13	14	15	16	17
	9	13	8	7	7	7	8	25	8	10	11	10	12	13	14
	18	19	20-21												
	14	17	29=1000;												

joints 20 and 21 are fused on the right. In another specimen first antenna extends to the end of genital segment. Second antenna with exopodite 1.3 times as long as endopodite. Mandible with a short endopodite, bearing 9 setae on the distal margin. In first maxilla the spinulation of various parts as follows: outer lobe has 6 setae; exopodite has 9 setae; endopodite has 9 setae; second basal has 2 setae; third inner lobe has one seta; second inner lobe has one seta respectively. Second maxilla much reduced.

First leg has an outer edge spine on first joint of exopodite reaching about distal margin of second joint of exopodite (fig. *e*). Second leg with 2-jointed endopodite; terminal spine of exopodite long, and has 35 teeth (fig. *f*). Exopodite of third leg missing. Fourth leg has 3-jointed exopodite and endopodite; terminal spine of exopodite has 33 teeth (fig. *g*). Fifth pair of legs are short; they are shorter than half the length of fourth leg (fig. *h*).

Remarks. The present specimen resembles male of *Ch. poppei* in its small size, but slender cephalothorax, shape of thoracic spines, long terminal spines of exopodite of second to fourth legs and the proportional lengths of fifth pair of legs are different from those of the former.

Occurrence. Each an adult male both from Sagami and Suraga from the depth 1000 m to the surface, Nov. and Dec. 1937.

Chiridius molestus sp. nov.

(Fig. 33, *a-f*)

Male. Length, 2.04 mm; cephalothorax, 1.43 mm; abdomen, 0.61 mm. Body elongate ovate; the greatest width slightly less than half the length of cephalothorax. Head conspicuously dilated in oral region. Fourth and fifth thoracic segments fused (fig. *a*). Posterior margin of last thoracic segment with minute spines which are more convergent than those found in the male of *Ch. poppei* (fig. *c*). Rostrum as those of females of other members of the genus (fig. *b*).

Abdominal segments and furca with proportional lengths 17:25:23:19:3:13=100; furcal rami 1.5-times as long as wide.

First antenna 23-jointed, reaches back to the middle of third abdominal segment; proportional lengths of joints as follows:

Joint	1	2	3	4	5	6	7	8-9-10	11	12	13	14	15	16	17
	28	22	17	17	17	21	21	68	28	34	34	34	45	56	62
	18	19	20	21	22	23	24	25							
	62	79	79	56	73	68	62	17=1000;							

joints 20 and 21 are fused on the right side; joint 24 is incompletely separate from the 25th; proximal joints are furnished with well developed aesthetascs. Second antenna with exopodite about 1.5-times as long as endopodite. Endopodite of mandible

is short, and has 8 setae. Second maxilla reduced much. Second basal joint of maxillipede is longer than the first; first joint of endopodite has 4 setae, of which the middle one is very strong.

In first leg first joint of exopodite has an outer edge spine, not reaching the end of second joint of exopodite (fig. *d*). Second leg with 1-jointed endopodite; line

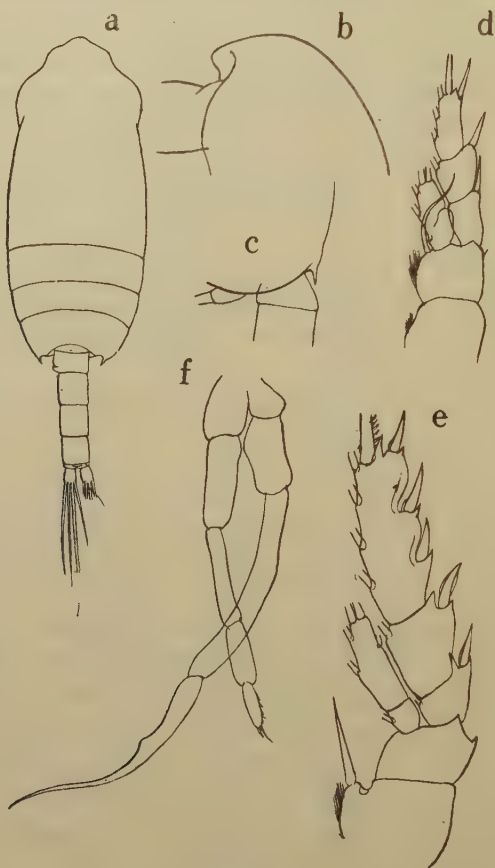


Fig. 33. *Chiridius molestus* sp. nov.

a, Male: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment, lateral aspect; *d*, 1st leg; *e*, 2nd leg; *f*, 5th pair of legs.

of fusion between first and second joints is found on the anterior surface; terminal spine of exopodite has 32 teeth (fig. *e*). Third leg with 3-jointed endopodite; terminal spine of exopodite has 29 teeth. Fourth leg slender; terminal spine of exopodite has 24 teeth. Fifth pair of legs slender, resemble those of *Ch. obtusifrons* Sars; left leg about two-thirds the length of the right; terminal joint of left leg has two unequal spines on the apex (fig. *f*).

Remarks. The specimens resemble *Ch. gracilis*, but lateral spines of last thoracic segment are small.

Occurrence. Two males from Suruga, July, 1937, and three males from Sagami, Nov. 1937, in the vertical hauls from the depth 1000 m to the surface. The specimen is the richest in number among the male of the genus.

Chiridius carnosus sp. nov.

(Fig. 34, a-f)

Male. Length, 2.36 mm: cephalothorax, 1.77 mm; abdomen, 0.51 mm. General appearance as those of males of *Aetideus*. Cephalothorax elongate ovate. Head fused

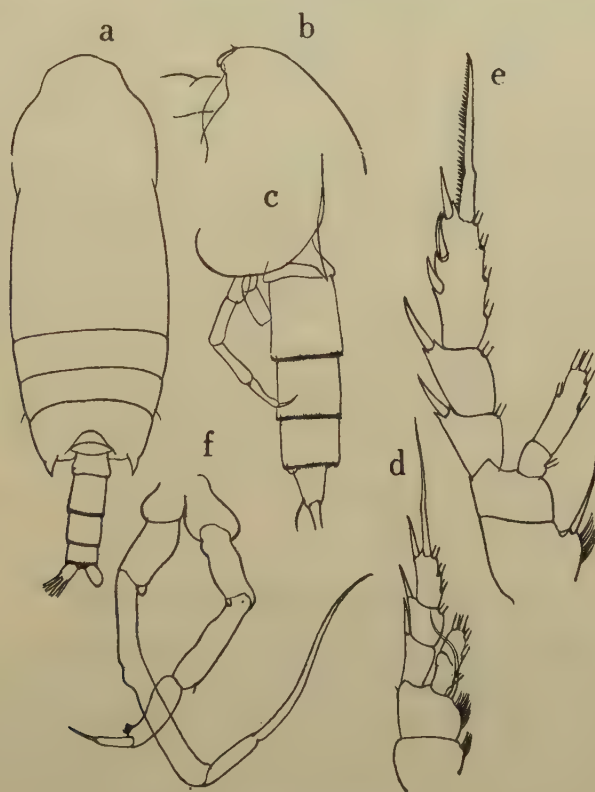


Fig. 34. *Chiridius carnosus* sp. nov.

a, Male: dorsal aspect; b, head, lateral aspect; c, last thoracic segment and abdomen, lateral aspect; d, 1st leg; e, 2nd leg; f, 5th pair of legs.

with first thoracic segment; fourth and fifth thoracic segments are incompletely fused (fig. a). Base of lateral spines of last thoracic segment wide (fig. c). Rostrum one-

pointed, looks like a beak (fig. *b*).

Abdomen 5-segmented, segments and furca with proportional length 18:22:25:18:2:15=100. Anal segment very short, concealed beneath the foregoing. Furcal rami about 1.3-times as long as wide.

First antenna 23-jointed, reaches back to distal end of second abdominal segment; joints are in proportional lengths.

Joint	1	2	3	4	5	6	7	8-9-10	11	12	13	14	15	16	17
	71	47	24	19	24	28	28	96	28	28	33	33	43	47	52
	18	19	20	21	22	23	24	25							
	52	62	62	43	62	57	47	14=1000;							

joints 20 and 21 are fused on the right proximal joints with long aesthetascs. Second antenna with exopodite 1.25-times as long as endopodite; first basal joint has a row of long stiff hairs. Mandible has a short endopodite. First maxilla has 9 setae on endopodite, 5 setae first outer lobe, 9 setae on exopodite. Second maxilla shows no characteristic features. In maxilliped first and second basal joints, and endopodite have the proportional lengths: 35, 24 and 18.

First leg with 3-jointed exopodite; outer edge spines of the exopodite slender and long (fig. *d*). Second leg with 2-jointed endopodite; terminal spine of exopodite has 37 teeth (fig. *e*). Third leg has 3-jointed endopodite; exopodite broken off. Fourth leg broken off; first basal joint without inner marginal hairs. Fifth pair of legs resemble those of *Ch. armatus* Sars, with a very rudimentary endopodite on second basal joint on each side; distal joint of the right leg very slender and long (fig. *f*).

Remarks. The specimen appears to be a member of the genus *Chiridius*, but the structure of the fifth pair of the male legs indicates a close relationship to *Aetideopsis*.

Occurrence One male from Sagami, Nov. 1937, in the vertical haul from 1000-0 m.

Genus *Chiridiella* G. O. Sars, 1907

Two species belonging to the genus have been detected in the collection. The genus differs from *Chiridius* in the followings: last thoracic segment has no lateral spines; exopodite of second antenna little longer than endopodite; exopodite of mandible small; first maxilla reduced; second maxilla and maxilliped very characteristic; first leg has 1-jointed endopodite; third and fourth legs with 3-jointed exopodite and endopodite, the joints of both exopodite and endopodite broad. Fifth leg absent in female. These characteristics indicate that the genus is quite a stranger among the family Aetideidae, although male fifth pair of legs show close relationship to *Gaidius* and *Gaetanus*. The systematic position remains uncertain till more species that have the similar structure in mandible and maxillae to those of this genus have been found.

Chiridiella macrodactyla G. O. SARS

(Fig. 35, a-g)

Chiridiella macrodactyla FARRAN, 1908, p. 46, pl. 4; A. SCOTT, 1909, p. 79, pl. 35; G. O. SARS, 1925, p. 50, pl. 16.

Female. Length, 2.57 mm: cephalothorax, 2.13 mm; abdomen, 0.44 mm. Cephalothorax ovate in outline. Head fused with first thoracic segment (fig. a). Last two thoracic segments fused. Rostrum absent.

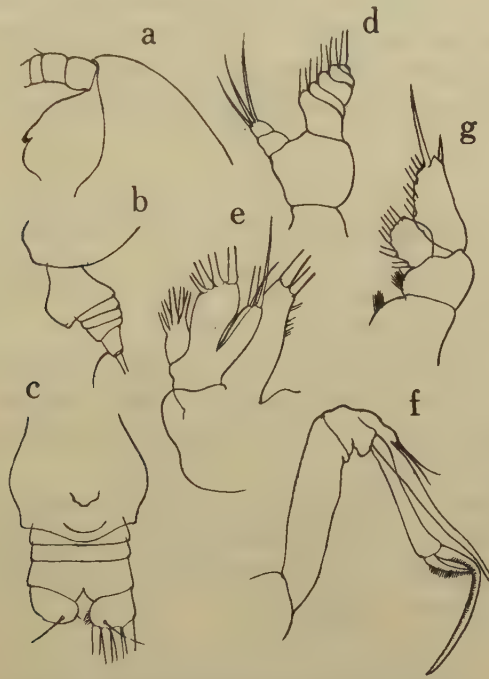


Fig. 35. *Chiridiella macrodactyla* G. O. SARS.

a, Female: head, lateral aspect; b, last thoracic segment and abdomen, lateral aspect; c, abdomen, ventral aspect; d, mandible palp; e, 1st maxilla; f, 2nd maxilla; g, 1st leg.

Abdomen 4-segmented, segment and furca with proportional lengths 40:12:12:12:20:16=100. Genital segment much wider than long, and produced considerably below. Furcal rami wider than long, carries short setae (fig. b, c).

Second antenna has 7-jointed exopodite which is 1.2-times as long as endopodite (31:26). Mandible simple; endopodite bears three setae on the distal joint; exopodite has five setae (fig. d); biting part strong and well developed. In first maxillar exopodite with five setae, endopodite with four setae, third inner lobe with three setae, first inner

lobe ten setae; setae on outer lobe were not observed (fig. *e*). Second maxilla very characteristic; according to Sars, it is furnished with four lobes, among which the proximal two are simple, and each carries two setae; in the present specimen first lobe was absent; second lobe is small and has no seta; distal two lobes as those described by Sars (fig. *f*). Maxillipede slender and long; the second basal about 1.4-times as long as the first.

First leg has 1-jointed exopodite and endopodite (fig. *g*). Second leg has 3-jointed exopodite and 1-jointed endopodite. Third and fourth legs have 3-jointed exopodite and endopodite. Fifth leg absent.

Remarks. The present specimen, except minute points of difference in the structure of mandible, maxillae, agrees fairly well with the Sars' description and figures.

Occurrence. One adult female from Suruga in a haul from 1000-0 m, July, 1937.

Distribution. The species has been recorded from the deep waters of the Atlantic and Malay Archipelago.

Chiridiella brachydactyla G. O. Sars

(Fig. 36, *a-j*)

Chiridiella brachydactyla Sars, 1925, p. 51. (Female)

Male. Length, 2.36 mm: cephalothorax, 1.75 mm; abdomen, 0.61 mm. Cephalothorax oblong ovate. Head fused with first thoracic segment. Fourth and fifth thoracic segments fused (fig. *a, b*). Lateral corners of last thoracic segment rounded (fig. *c*).

Abdomen 5-segmented, segments and furca in the proportional lengths 27:21:15:18:6:15=100; furcal rami about as long as wide (fig. *d*).

First antenna 24-jointed, exceeds distal margin of furca by terminal two joints; joints are in the proportional length:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	21	24	18	21	21	24	24	45	29	32	34	47	47	58	66	66
	18	19	20	21	22	23	24	25								
	61	71	71	61	58	50	42	11	=1000;							

joints 12 and 13 are incompletely fused. Second antenna has exopodite about 1.3-times as long as endopodite; first basal joint has a tuft of hairs on the posterior surface; first joint of endopodite very voluminous (fig. *e*). Mandible has exopodite about as long as endopodite; biting part thin-skinned (fig. *f*). In first maxilla outer lobe has 5 long setae, exopodite has 10 setae, endopodite and inner lobes reduced. Second maxilla reduced; fourth and fifth lobes are large, each with a strong spine at the apex (fig. *g*). Maxillipede slender; fifth lobe of first basal joint has a peculiar spine forked at the apex (fig. *h*).

First leg has 1-jointed exopodite and endopodite. Second leg with 3-jointed

exopodite and 2-jointed endopodite; according to Sars, endopodite is 1-jointed in the female, but in the present male specimen line of separation between first and second joints well marked on either side of the joint, especially vivid on anterior surface; joints of exopodite broad; the terminal spine of the exopodite has 45 teeth (fig. *i*). Third and fourth legs with 3-jointed exopodite and endopodite. Fifth pair of legs resemble those of *Gaidius* (fig. *f*).

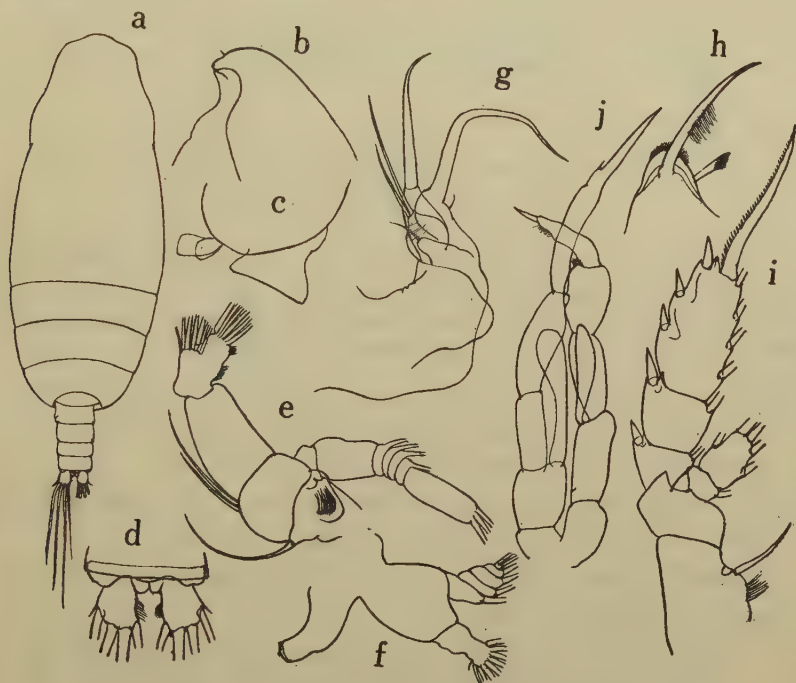


Fig. 36. *Chiridiella brachydactyla* G. O. Sars.

a, Male: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment, lateral aspect; *d*, anal segment and furca; dorsal aspect; *e*, 2nd antenna; *f*, mandible; *g*, 2nd maxilla; *h*, distal margin of 1st basal joint of maxillipede; *i*, 2nd leg; *j*, 5th pair of legs.

Remarks. The male specimen has not been reported before. Some authors comprises the genus *Chiridiella* in the family Euchaetidae, but Sars rightly comprised it in the family Aetideidae. The structure of male fifth pair of legs indicates that the genus is closely allied to the member of the family Aetideidae.

Occurrence. One adult male from Sagami, in a vertical haul from 1000 m to the surface, Nov. 1937.

Distribution. The species has been recorded from the deep waters of the Atlantic.

Genus *Gaidius* GIESBRECHT, 1895

Up to the present time, none of the species belonging to the genus has been recorded from Japanese waters. I have found in the collection the following species: *Gaidius tenuispinus* Sars, *G. minutus* Sars, *G. brevispinus* Sars and *G. moderatus* n.sp. The genus is characterized by one-pointed rostrum, short endopodite of second antenna, and two jointed endopodite of first leg. Male resembles female in general appearance, and is characterized by the reduction of thoracic spine; mouth parts and outer edge spine of second joint of exopodite of first leg are also reduced. Fifth pair of legs have each a rudimentary endopodite on second basal joint.

Gaidius tenuispinus G. O. Sars, 1900(Fig. 37, *a-k*)

Chiridius tenuispinus Sars, 1903, p. 30; *Gaidius similis* A. Scott, 1909, p. 51, pl. 7; *Gaidius tenuispinus* Esterly, 1911, p. 316; With, 1915, p. 89; Sars, 1925, p. 46; Farran, 1926, p. 249; Farran, 1929, p. 231; Sewell, 1929, p. 100; Jespersen, 1934, p. 58; Brodsky, 1950, p. 164; Vervoort, 1950, p. 15; Vervoort, 1951, p. 81.

Female. Length, 3.44 mm: cephalothorax, 2.75 mm; abdomen, 0.69 mm. The specimen agrees quite well with the description and figures given by Sars. Lateral spines of last thoracic segment slender and long (fig. *a, b, c*).

Abdomen 4-segmented, segments and furca in the proportional lengths 41:18:13:10:18=100; furcal rami about 1.3-times as long as wide.

First antenna 24-jointed, extends about to distal margin of 2nd abdominal segment; joints with proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	29	50	23	26	26	29	29	44	23	23	23	41	41	44	48	50
	18	19	20	21	22	23	24	25								
	53	70	54	53	70	67	56	20=1000.								

Mouth parts and swimming legs as figured by Sars. Number of teeth on terminal spine of exopodite of second to fourth legs are 23, 20 and 26 respectively. First basal joint of maxillipede (fig. *d*) and first leg (fig. *e*) as shown in the figure.

Male. Length, 2.07 mm: cephalothorax, 1.67 mm; abdomen, 0.60 mm. The general appearance as Sars' figure (fig. *f, g, i*). Rostrum somewhat differs from the figures given by With; it is not so sharply produced (fig. *h*). Abdomen 5-segmented, segments and furca with proportional lengths 19:30:19:19:2:11=100; furcal rami about as long as wide.

First antenna 21-jointed, extends to distal margin of second abdominal segment; joints are in proportional length:

Joint	1	2	3	4	5	6	7	8-9-10	11	12-13	14	15	16	17
	27	27	16	21	26	26	32	69	27	63	37	48	53	58
	18	19	20-21	22	23	24	25							
	63	74	128	79	74	43	11=1000.							

Second antenna with exopodite about as long as endopodite; first basal joint has rows of hairs on posterior surface; and a strong inner marginal seta. Mandible with a

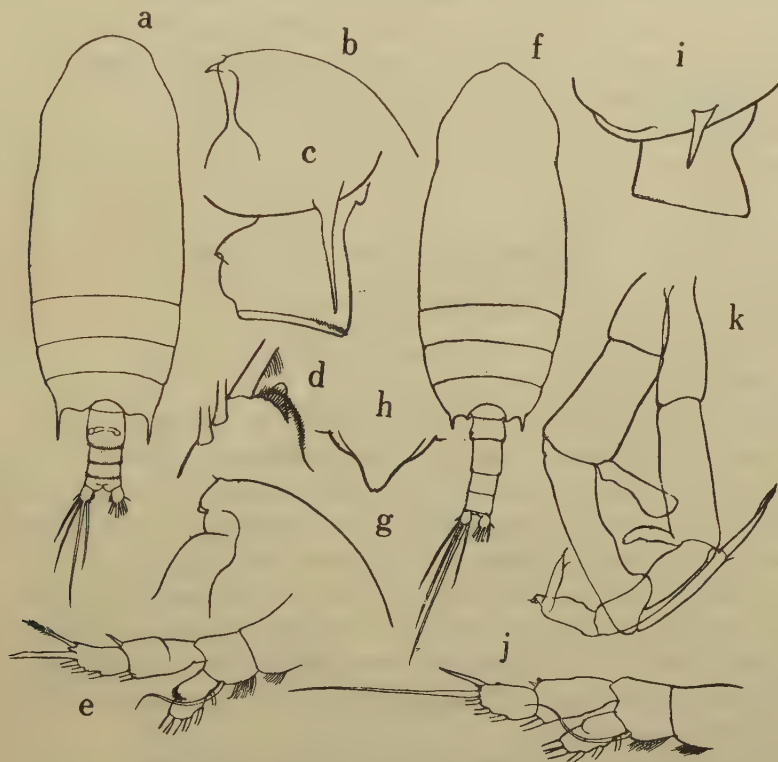


Fig. 37. *Gaidius tenuispinus* (G. O. Sars).

a, Female: dorsal aspect; b, head, lateral aspect; c, last thoracic segment and genital segment, lateral aspect; d, distal margin of 1st basal joint of maxillipede; e, 1st leg; f, Male: dorsal aspect; g, head, lateral aspect; h, rostrum, anterior aspect; i, last thoracic segment, lateral aspect; j, 1st leg; k, 5th pair of legs.

robust second basal joint. Outer lobe of maxilla has 7 setae, exopodite has 11 setae, endopodite has 9 setae. Second maxilla reduced and thin-skinned. Maxillipede has slender basal joints.

In first leg first and second joints of exopodite are fused; outer edge spine of second joint of exopodite is very minute; third joint of exopodite has a slight prominence furnished with fine spinules on the distal one-third of the outer margin

(fig. *j*). Second leg has 1-jointed endopodite; in exopodite outer edge spine of second joint reaches the base of proximal spine of third joint; distal outer edge spine of third joint is about half as long as third joint of exopodite; terminal spine has 24 teeth. Third and fourth legs have each 3-jointed endopodite; number of teeth on terminal spine of exopodite are 17, and 14 respectively. Fifth pair of legs as figured by SARS (fig. *k*).

Remarks. Male specimen resembles *Gaidius similis* A. SCOTT, but differs from it in the followings: shape of rostrum, minute outer edge spine of second joint of exopodite of first leg, one-jointed endopodite of second leg, and small size.

Occurrence. Two adult and three immature females and one adult male from Sagami, in vertical hauls from 1000-0 m.

Distribution. The species appears to be widely distributed in the Pacific, Atlantic and Indian Oceans.

Gaidius brevispinus G. O. SARS

(Fig. 38, *a-k*)

Gaidius brevispinus SARS, 1903, p. 162; WITH, 1915, p. 94; SARS, 1925, p. 48; BRODSKY, 1950, p. 158.

Female. Length, 4.40 mm: cephalothorax, 3.45 mm; abdomen, 0.95 mm; so abdomen is contained 3.6-times in length of cephalothorax. Cephalothorax moderately robust (fig. *a, b*). Lateral corners of last thoracic segment broadly rounded, with short oblique spine (fig. *c*). Rostrum one-pointed, slightly notched at the apex.

Abdomen 4-segmented, segments and furca with proportional length 40:15:9:17:19=100. Genital segment robust. Furcal rami 1.4-times as long as wide.

First antenna 24-jointed, reaches back to distal end of third abdominal segment. Mouth parts as those of other member of the genus; second maxilla has a lamellous process on the posterior margin about the middle of first basal joint. Maxillipede as shown in the figure (fig. *d*).

First leg has 3-jointed exopodite and 1-jointed endopodite; outer edge spine of second joint of exopodite is long and slender. Second leg has 3-jointed exopodite and 2-jointed endopodite; terminal spine of exopodite has 21 teeth (fig. *e*). Terminal spine of exopodite of third and fourth legs have each 21 and 27 teeth respectively. In fourth leg first basal joint has a row of bristles on the base of the inner marginal seta. Proportional lengths of terminal spine of exopodite to third joint of exopodite are as follows: second leg, 26:21, third leg, 28:25, fourth leg, 28:26.

Male. Length 2.94 mm: cephalothorax, 2.26 mm; abdomen, 0.68 mm. Cephalothorax robust; the greatest width 1.02 mm; lateral spines of last thoracic segment small (fig. *g*). Frontal organ prominent (fig. *f*). Rostrum notched at the apex (fig. *h*).

Abdomen 5-segmented, segments and furca with proportional lengths 23:26:18:15:3:15=100. Furcal rami 1.2-times as long as wide. Second to fourth segments

are fringed with fine teeth on the distal margin.

First antenna 21-jointed, extends to distal margin of second abdominal segment; joints are in the proportional lengths:

Joint	1	2	3	4	5	6	7	8-9-10	11	12	13	14	15	16	17
	26	29	22	22	26	26	29	66	29	33	29	29	54	56	56
	18	19	20-21	22	23	24-25									
	59	74	118	77	70	70=1000;									

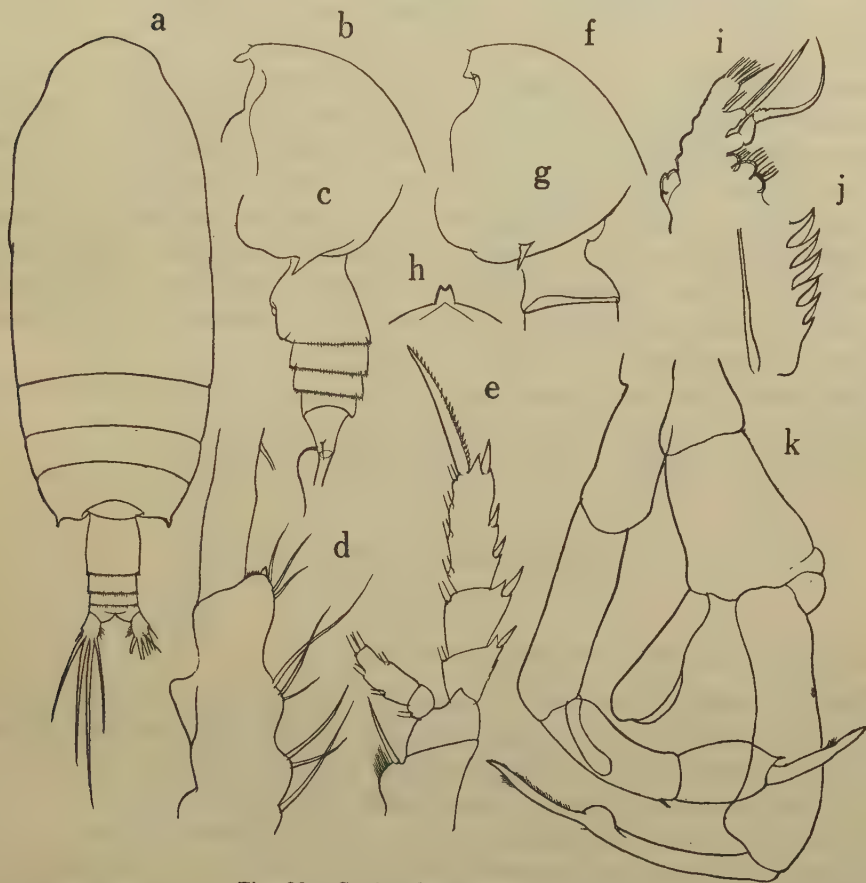


Fig. 38. *Gaidius brevispinus* G. O. Sars.

a, Female: dorsal aspect; b, head, lateral aspect; c, last thoracic segment and abdomen, lateral aspect; d, 1st basal joint of maxillipede; e, 2nd leg; f, Male: head, lateral aspect; g, last thoracic segment, lateral aspect; h, rostrum, anterior aspect; i, 2nd maxilla; j, terminal spine of exopodite of 4th leg; k, 5th pair of legs.

joints 24-25 are longer in proportion than those of *G. tenuispinus*. Second antenna, and mandible as in *G. tenuispinus*. First maxilla with 7+2 setae on outer lobe. Second maxilla reduced; fourth lobe has a remarkable seta (fig. i). Maxillipede slender.

First leg with 3-jointed exopodite second joint of exopodite with a minute outer edge spine; no protuberance on outer margin of third joint. Second leg with 2-jointed endopodite; terminal spine of exopodite has 27 teeth which is connected with lamellous thin plate. Third and fourth legs with 3-jointed endopodite; number of teeth on terminal spine of exopodite are 23 and 29 respectively (fig. j); first basal joint of fourth leg is smooth on the inner margin. Fifth pair of legs as those of the preceding species, and agree fairly well with Sars' figures of *tenuispinus* except that the endopodite of the left leg is shorter; second joint of exopodite of left leg is robust, and carries a single small spine on the inner distal margin (fig. k).

Remarks. The female specimens of *Gaidius brevispinus* (4.8 mm), *G. intermedius* WOLFENDEN (= *Mesogaidius intermedius*) (4.0–4.15 mm) and *G. affinis* Sars (3.60 mm) resemble each other in having a short spine on lateral corner of last thoracic segment; these three species have also a lamellous process on first basal joint of the maxillipede; their first antennae are of about equal proportional lengths. Comparing the present specimen with these three species, lamellous process of maxillipede comes nearest to that of *G. brevispinus*; outer edge spine of second joint of exopodite of first leg is longer than that of *G. intermedius*. It seems to be most reasonable to regard the present specimen as *G. brevispinus*.

Occurrence. Four adult females and one male from Sagami, in vertical hauls 1000–0 m.

Distribution. The species has been recorded from the Atlantic.

Gaidius minutus G. O. Sars

(Fig. 39, a–f)

Gaidius minutus Sars, 1925, p. 49; SEWELL, 1929, p. 100.

Female. Length, 2.62 mm; cephalothorax, 2.12 mm; abdomen, 0.50 mm. Cephalothorax robust. Head fused with first thoracic segment; the fourth and fifth are fused (fig. a, b, c). Last thoracic segment produced into a small nodule on each side. Rostrum short, one-pointed, slightly notched at the apex (fig d).

Abdomen 4-segmented, segments and furca with proportional lengths 42:13:11:11:23=100. Genital segment produced below. First three segments are fringed with fine teeth on the distal margin. Furcal rami 1.5-times as long as wide.

First antenna 24-jointed, reaches back to distal end of abdomen; joints are in the following proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	34	37	24	24	27	30	30	44	24	27	27	44	44	47	50	50
	18	19	20	21	22	23	24	25								
	54	67	61	50	67	61	54	24=1000.								

Second antenna with exopodite a little longer than endopodite. First maxilla with 9 setae on outer lobe, 11 setae on exopodite, 14 setae on endopodite, 5 setae on second basal joint, 4 setae on third inner lobe, 14 setae on first inner lobe. In maxillipede distal inner lobe of first basal joint has, beside usual 3 setae, a small lamellous process.

In first leg first and second joints of exopodite fused; outer edge spine of third joint is longer than the joint itself (fig. *e*). Second to fourth legs are of *Aetideus*-

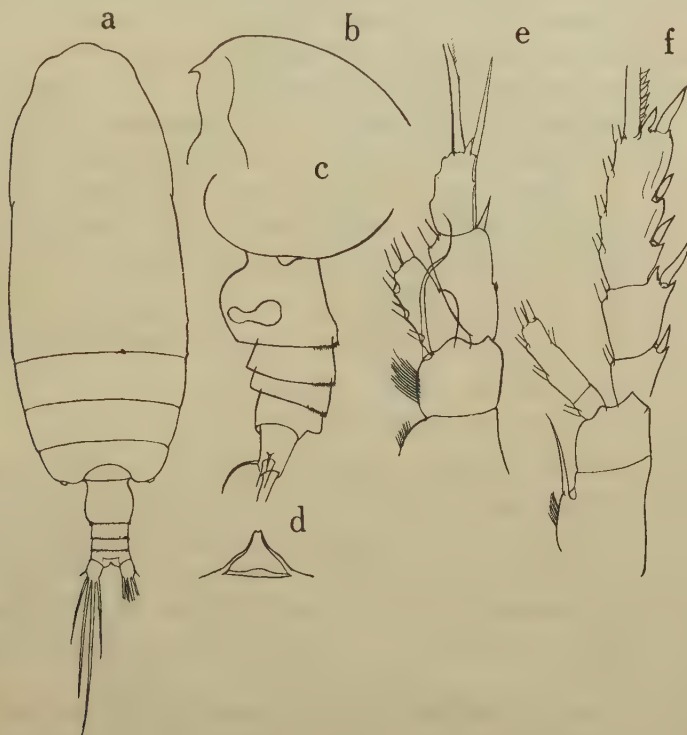


Fig. 39. *Gaidius minutus* G. O. SARS.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, rostrum, anterior aspect; *e*, 1st leg; *f*, 2nd leg.

type; terminal spine of exopodite of second leg has 19 teeth (fig. *f*). Fourth leg has stiff hairs on inner margin near base of inner marginal spine of first basal joint.

Remarks. The present specimen, though slightly differs from SARS' description in having small nodules on lateral corner of last thoracic segment, agrees quite well in other respects with *G. minutus*.

Occurrence. Each an adult female both from Sagami and Suruga, from the deep layers.

Distribution. The species has been recorded from the Atlantic and Indian Oceans.

Gaidius moderatus sp. nov.(Fig. 40, *a-p*)

Female. Length, 3.53 mm: cephalothorax, 2.78 mm; abdomen, 0.75 mm; so abdomen is contained 3.7-times in the length of cephalothorax. Cephalothorax moderately robust, and oval in dorsal view; the greatest width little shorter than half the length of cephalothorax; head fused with first thoracic segment; last two thoracic segments are fused (fig. *a, b*). Lateral spines of last thoracic segment rather slender, and somewhat convergent; the spine does not reach the middle of genital segment (fig. *c*). Rostrum triangular and slightly notched at the apex (fig. *f*).

Abdomen 4-segmented, segments and furca with proportional lengths 39:17:15:12:17=100. Genital segment produced below. First three segments are furnished with fine teeth on the distal margin. Furcal rami little longer than wide (7:6).

First antenna 24-jointed, reaches back to distal margin of genital segment when fully extended; joints are in the following proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	32	45	22	22	26	30	30	48	25	25	25	42	45	48	51	51
	18	19	20	21	22	23	24	25								
	51	67	61	48	67	64	54	22=1000;								

second to eighth joints have several fine hairs on posterior margin. Second antenna has exopodite 1.2-times as long as endopodite; exopodite robust; inner marginal setae of second joint of endopodite is based each on a small knob; endopodite slender. Mandible as in other members of the genus. First maxilla as shown in the figure; outer lobe has 9 setae; exopodite 11 setae; endopodite 14 setae (fig. *g*). Second maxilla as that of *G. minutus*. Maxillipede has a small lamellous process on fourth lobe of first basal joint (fig. *h*).

First leg with 2-jointed exopodite; line of fusion between the first and second joints faintly visible on anterior surface (fig. *i*). Second leg with 2-jointed endopodite; terminal spine of exopodite has 19 teeth which are connected with a sort of lamina. Third leg with 3-jointed endopodite; terminal spine of exopodite has 17 teeth. Fourth leg has a row of stiff hairs on inner margin of first basal joint; terminal spine of exopodite has 20 teeth (fig. *k*).

Male. Length, 3.19 mm: cephalothorax, 2.46 mm; abdomen, 0.3 mm; the greatest width of cephalothorax, 1.00 mm. Lateral spines of last thoracic segment, though broken off in the distal part, appears to be fairly long, and reaches the middle of first abdominal segment; it is convergent and moderately wide at the base (fig. *l, o*). Rostrum acutely pointed when viewed from the lateral; the apex slightly notched (fig. *m, n*).

Abdomen 5-segmented, segments and furca with proportional lengths 19:29:19:17:2:14=100. Furcal rami about 1.3-times as long as wide; furcal setae more than 2-times as long as abdomen and furca taken together.

First antenna 20-jointed, extends to distal margin of furca; joints are in the following proportional lengths;

Joint	1	2	3	4	5	6	7	8-9-10	11	12-13	14	15	16	17
	33	36	23	23	26	30	30	69	27	60	33	48	51	54
	18	19	20-21	22	23	24-25								
	58	69	114	75	72	69=1000.								

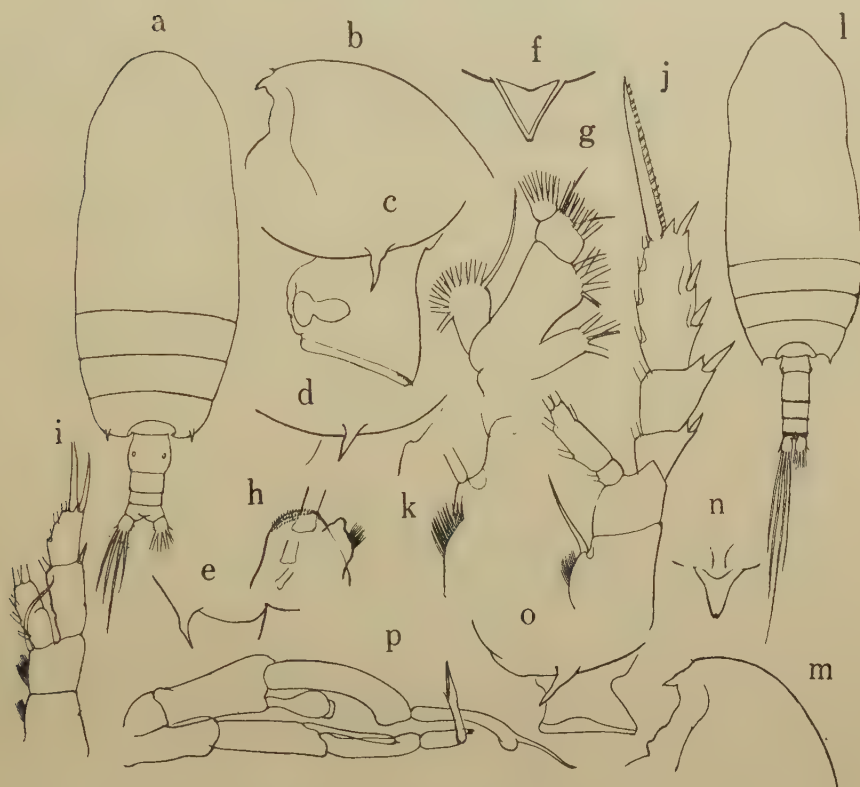


Fig. 40. *Gaidius moderatus* sp. nov.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and genital segment, lateral aspect; *d*, last thoracic segment, lateral aspect, other specimen; *e*, lateral spine of last thoracic segment, dorsal aspect; *f*, rostrum, anterior aspect; *g*, 1st maxilla; *h*, distal margin of 1st basal joint of maxillipede; *i*, 1st leg; *j*, 2nd leg; *k*, inner margin of 1st basal joint of 4th leg; *l*, Male: dorsal aspect; *m*, head, lateral aspect; *n*, rostrum, anterior aspect; *o*, last thoracic segment, lateral aspect; *p*, 5th pair of legs.

Second antenna as those of the foregoing species; first joint of exopodite is furnished with long hairs on the inner margin. Mandible with a wide second basal joint. First maxilla much reduced, and has 7 long setae on first outer lobe, 11 setae on exopodite,

10 setae on endopodite. Second maxilla and maxillipede as those of the male of foregoing species.

First leg with 2-jointed exopodite; line of fusion between first and second joint faintly visible on the anterior surface. Second leg with 2-jointed endopodite; exopodite broken off. In fourth leg first basal joint is smooth on the inner margin. Fifth pair of legs as those of the foregoing species (fig. *p*).

Remarks. Female specimen resembles *Gaidius pungens* GIESBRECHT, except for the following minute points of difference: posterior spines of last thoracic segment are shorter in proportion than figured by GIESBRECHT; endopodite of second leg 1-jointed in GIESBRECHT's specimen, but the present specimen has 2-jointed endopodite. Posterior spines of last thoracic segment show some variations as shown in the figure.

Occurrence. One female and one male from Sagami, in vertical hauls from 1000-0 m.

(To be continued)

THE PELAGIC COPEPODS OF THE IZU REGION, MIDDLE JAPAN
SYSTEMATIC ACCOUNT IV.

FAMILY AETIDEIDAE (PART 2)

OTOHIKO TANAKA

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THE PELAGIC COPEPODS OF THE IZU REGION, MIDDLE JAPAN SYSTEMATIC ACCOUNT IV.

FAMILY AETIDEIDAE (PART 2)

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With 21 Text-figures

Family AETIDEIDAE

Genus *Gaidiopsis* A. SCOTT, 1909

A. SCOTT created the genus *Gaidiopsis* to accomodate a single species, *Gaidiopsis crassirostris*, which differs from *Gaidius* in the followings: last two thoracic segments completely separate; exopodite of first leg 3-jointed; endopodite of second leg distinctly 2-jointed. I have, up to present, found no specimen belonging to the genus from the Izu region.

Genus *Gaetanus* GIESBRECHT, 1888

Up to the present time two species of this genus have been recorded from the Japanese waters: they are *G. armiger* GIESBRECHT and *G. minor* FARRAN. I have found three more species in the collection: *Gaetanus kruppi* GIESBRECHT, *G. miles* GIESBRECHT and *G. pileatus* FARRAN. The genus resembles *Gaidius* in general structure: head has a median spine; first antenna 24-jointed; second antenna with endopodite which is shorter than exopodite; mandible, maxillae and maxillipede as those of *Gaidius*; exopodite of first leg 2-jointed or sometimes 3-jointed; fourth leg with spines on inner margin of first basal joint; fifth leg absent in female; fifth pair of legs of male resemble those of *Gaidius*.

Gaetanus kruppi GIESBRECHT

(Fig. 41, a-g)

Gaetanus kruppi GIESBRECHT, 1904, p. 202; A. SCOTT, 1909, p. 48; WITH, 1915, p. 97; G. O. SARS, 1925, p. 61; FARRAN, 1926, p. 249; SEWELL, 1929, p. 102; WILSON, 1932, p. 52; JESPERSEN, 1934, p. 62; SEWELL, 1947, p. 62.

Female. Length, 4.95 mm : cephalothorax, 3.95 mm ; abdomen, 1.00 mm. Cephalothorax rather slender, about 2.9-times as long as wide. Forehead with a median spine directing forwards and slightly downward (fig. *a*, *b*). Rostrum short. Lateral spines of last thoracic segment slightly divergent, reaching the middle of genital segment (fig. *c*).

Abdomen 4-segmented ; segments and furca with proportional lengths 42:17:12:12:17=100 ; furcal rami a little longer than wide.

First antenna 24-jointed, extends beyond distal end of abdomen by last three joints ; joints are in the proportional lengths :

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	56	34	16	19	25	25	28	47	22	25	28	53	50	56	53	56
	18	19	20	21	22	23	24	25								
	53	65	59	50	65	56	40	19=1000								

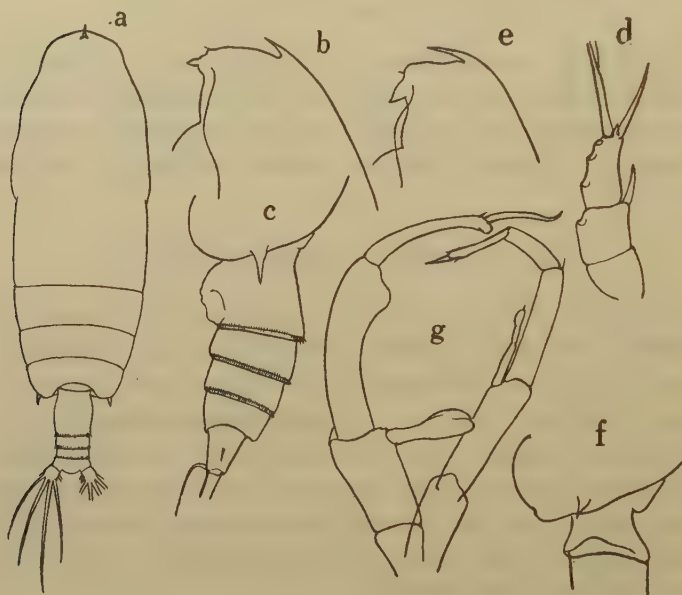


Fig. 41. *Gaetanus kruppi* GIESBRECHT.

a, Female: dorsal aspect ; *b*, head, lateral aspect ; *c*, last thoracic segment and abdomen, lateral aspect ; *d*, exopodite of first leg ; *e*, Male: head, lateral aspect ; *f*, last thoracic segment, lateral aspect ; *g*, fifth pair of legs.

WITH describes that joints 2, 8-9 and 20 are of about equal lengths, but in the present specimen the 20th is the longest. Second antenna with exopodite about 1.2-times as long as endopodite ; distal joint of endopodite bears 14 setae. Mandible has a small exopodite. First maxilla with 7+2 setae on outer lobe, 11 setae on exopodite, 4+4+7 setae on endopodite, 5 setae on second basal, 4 setae on third inner lobe, 4 setae on

second inner lobe; third inner lobe has, beside 4 setae, a conical process. Second maxilla not characteristic. Maxillipede with a lamellous process on the middle of the anterior surface of first basal joint.

First leg with an articular membrane between first and second joints of exopodite (fig. *d*). Second leg has 20 teeth on terminal spine of exopodite; teeth are connected by a sort of lamella; endopodite 2-jointed. Third leg with 21 teeth on terminal spine of exopodite. Fourth leg has 14 stiff triangular pointed marginal bristles on posterior surface of first basal joint.

Male. Length, 4.87 mm: cephalothorax, 3.75 mm; abdomen, 1.12 mm; the greatest width of cephalothorax, 1.38 mm. Cephalothorax more slender than that of the female. Cephalic spine slender and long (fig. *e*). Rostrum more clumsy. Lateral spines of last thoracic segment shorter (fig. *f*).

Abdomen 5-segmented; segments and furca with proportional lengths 20:28:22:15:3:12=100; furcal rami about as long as wide.

First antenna extends to the middle of third abdominal segment; the segmentation in 8th to 14th joints are, as stated by WITH, difficult to make out; joints are in the proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	55	32	20	20	24	28	32	52	16	28	26	24	24	55	55	60
	18	19	20-21	22	23	24-25										
	60	72	120	75	72	60=1000.										

Second antenna has exopodite about as long as endopodite; first joint of exopodite is furnished with hairs on the posterior margin; first joint of endopodite rather clumsy. Mandible has a broad second basal joint furnished with a single short seta; both exopodite and endopodite well developed; First maxilla slightly reduced; outer lobe has 7, long setae and 2 short ones; exopodite has 11 setae; endopodite has 5+2+2 setae; second basal joint has one long and 2 short setae. Second maxilla much reduced and soft-skinned. Maxillipede has no lamellous process on first basal as observed in the female; distal part of first basal joint is produced into a claw-like lamellous process.

In first leg, outer edge spine of second joint of exopodite is represented by a minute spinule. Terminal spine of exopodite of second leg has 29 to 34 teeth, that of third and fourth leg have each 28 and 30 teeth respectively. Fifth pair of legs as described by WITH, but the small process at base of third joint of exopodite of left leg was not observed in the present specimen (fig. *g*).

Occurrence. Six females and three males from Sagami, Nov. 1937, one female from Suruga, Dec. 1937, from 1000 to the surface.

Distribution. The species is widely distributed in the deep waters of the Atlantic, Pacific and Indian Oceans.

Gaetanus armiger GIESBRECHT(Fig. 42, *a-d*)

Gaetanus armiger GIESBRECHT, 1892, p. 219; A. SCOTT, 1909, p. 45; SARS, 1925, p. 59; SEWELL, 1929, p. 101; MORI, 1937, p. 40.

Female. Length, 3.37 mm: cephalothorax, 2.62 mm; abdomen, 0.75 mm. Cephalic spine slender and short, directing forwards (fig. *a*). Rostrum small; frontal prominence low (fig. *b*). Lateral spines of last thoracic segment divergent, and extend beyond the middle of genital segment. Articulation between fourth and fifth thoracic segments slightly visible in dorsal aspect (fig. *c*).

Abdomen 4-segmented; segments and furca with proportional lengths 52:22:19:15:22=100. Genital segment as long as wide. Furcal rami about 1.2-times as long as wide.

First antenna 23-jointed, extends to distal end of third abdominal segment; proportional lengths of the joints:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	54	37	20	20	23	25	28	45	28	28	28	48	48	51	51	54
	18	19	20	21	22	23	24-25									
	54	65	57	51	62	57	68=1000;									

joints 24-25 are 1.05-times as long as joint 19; according to GIESBRECHT, joints 22 and 23 are of equal lengths, but in the present specimen joint 22 is 1.1-times as long as the 23rd. Second antenna with exopodite 1.2-times as long as endopodite. Maxillae as those of the preceding species. Maxillipede has no lamellous process on the distal margin of first basal joint.

Exopodite of first leg as shown in the figure (fig. *d*). Terminal spine of exopodite of second to fourth legs have 18, 18 and 27 teeth respectively; fourth leg bears 17 spines on inner margin of first basal joint at the base of inner marginal seta.

Occurrence. One adult female from Sagami, Nov. 1937, from 1000-0 m.

Distribution. The species has a wide distribution, and has been recorded from the Pacific, Atlantic, Indian Oceans, Malay Archipelago and the Gulf of Guinea.

Gaetanus minor FARRAN(Fig. 42, *e-g*)

Gaetanus minor FARRAN, 1905, p. 34; FARRAN, 1908, p. 37; A. SCOTT, 1909, p. 47; WOLFENDEN, 1911, p. 233; WITH, 1915, p. 103; SARS, 1925, p. 60; FARRAN, 1926, p. 250; SEWELL, 1929, p. 102; JESPERSEN, 1934, p. 62; FARRAN, 1936, p. 89; TANAKA, 1937, p. 257; SEWELL, 1947, p. 59.

Length. Female, 2.23 mm: cephalothorax, 1.82 mm; abdomen, 0.41 mm. Lateral spines of last thoracic segment reach about the end of genital segment (fig. *e, f*).

Abdomen 4-segmented; segments and furca with proportional length 44:17:13:9:17=100; furcal rami as long as wide; genital segment a little wider than long.

First antenna 23-jointed, reaches back to distal end of third abdominal segment; joints are in proportional lengths:

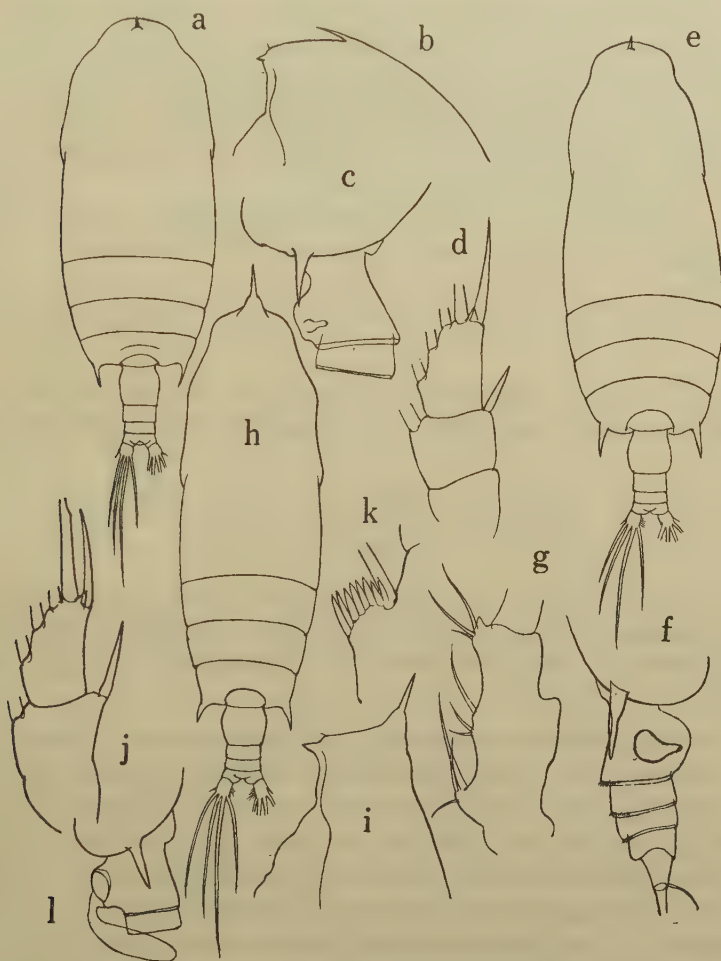


Fig. 42. *Gaetanus armiger* GIESBRECHT (a-d),
Gaetanus minor FARRAN (e-g),
Gaetanus miles GIESBRECHT (h-l).

a, *Gaetanus armiger*, Female: dorsal aspect; b, head, lateral aspect; c, last thoracic segment and genital segment, lateral aspect; d, exopodite of first leg; e, *Gaetanus minor*, Female: dorsal aspect; f, last thoracic segment and abdomen, lateral aspect; g, first basal joint of maxillipede; h, *Gaetanus miles*, Female: dorsal aspect; i, head, lateral aspect; j, exopodite of first leg; k, inner margin of first basal joint of fourth leg; l, last thoracic segment and genital segment, lateral aspect.

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	58	40	26	22	26	26	31	40	22	26	26	40	44	44	49	53
	18	19	20	21	22	23	24-25									
	53	69	57	44	67	57	53	27=1000;								

joints 19 and 22 are of about equal lengths. Second antenna with exopodite about 1.2-times as long as endopodite. In 1st maxilla second inner lobe carries, as described by WITH, two strong setae and short spine-like setae. Maxillipede with a lamellous process on first basal joint about the middle of posterior margin (fig. *g*).

First leg with 2-jointed exopodite. The number of teeth on terminal spine of second to fourth legs are 13, 15 and 13 respectively.

Remarks. I have previously collected an immature female specimen in the fifth copepodid stage from Suruga in the vertical haul from 500-250 m; the specimen measured 2.00 mm.

Occurrence. Six adult females from Sagami in the vertical hauls 1000-0 m, Nov. 1937.

Distribution. The species has a wide distribution, and has been reported from the North Atlantic, Indian Seas, Malay Archipelago and Great Barrier Reef region.

Gaetanus miles GIESBRECHT

(Fig. 42, *h-l*)

Gaetanus miles GIESBRECHT, 1982, p. 219, t. 14, 36; FARRAN, 1908, p. 36; A. SCOTT, 1909, p. 44; WOLFENDEN, 1911, p. 231; WITH, 1915, p. 107; SARS, 1925, p. 54; SEWELL, 1929, p. 102, WILSON, 1932, p. 51; JESPERSEN, 1934, p. 61; FARRAN, 1936, p. 89; SEWELL, 1947, p. 58; BRODSKY, 1950, p. 168.

Female. Length, 3.96 mm: cephalothorax, 3.25 mm; abdomen, 0.71 mm. Cephalic spine long. Rostrum short. Lateral spines of last thoracic segment divergent, and extend beyond the middle of genital segment (fig. *h, i, l*).

Abdomen is contained 4.6-times in the length of cephalothorax; abdomen 4-segmented, segments and furca with proportional lengths 41:15:13:13:18=100; genital segment wider than long; furcal rami as long as wide.

First antenna 23-jointed, about 2.6-times as long as total length of body; distal 10 joints exceeds end of furca; joints are in the proportional lengths;

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	20	19	12	12	16	18	21	42	25	30	32	46	48	58	62	67
	18	19	20	21	22	23	24-25									
	65	77	85	69	85	50	37=1000;									

according to GIESBRECHT joints 8-9, 13 and 24-25 are of equal lengths, but in the present specimen they agree with the description given by WITH: joint 13 is 1.1-times as long as joints 8-9, and 1.2-times as long as joints 24-25. Second

antenna with exopodite 1.2 times as long as endopodite. Outer lobe of first maxilla with 7+2 setae, endopodite with 11 setae, second inner lobe with 4 setae, third inner lobe with 4 setae and a small conical process. In maxillipede second basal joint 1.4-times as long as the first which is furnished with rounded lamellous process on the posterior margin.

In first leg outer edge spine of second joint of exopodite reaches almost the distal end of third joint of exopodite. Second leg has endopodite distinctly 2-jointed. First basal joint of fourth leg has knife-shaped spines on the inner margin (fig. *k*); the number of the spine is variable: according to GIESBRECHT, it is 6; A. SCOTT, 12; WITH, 15. Terminal spine of exopodite of second to fourth legs have 15, 17 and 16 teeth respectively.

Occurrence. One adult female from Sagami in the vertical hauls from 1000–0 m, Nov. 1937.

Distribution. The species has a wide distribution in the deep waters of the oceans.

Gaetanus pileatus FARRAN

(Fig. 43, *a–f*)

Gaetanus pileatus FARRAN, 1905, p. 33; ESTERLY, 1906, p. 57; A. SCOTT, 1909, p. 46; WOLFENDEN, 1911, p. 229; WITH, 1915, p. 104; SARS, 1925, p. 56; SEWELL, 1929, p. 103; FARRAN, 1936, p. 89; SEWELL, 1947, p. 59.

Female. Length, 6.14 mm; cephalothorax including cephalic spine 4.95 mm; abdomen, 1.19 mm; the greatest width of cephalothorax 1.75 mm. Cephalic spine has a characteristic shape (fig. *a*, *b*). Lateral spines of last thoracic segment divergent, and extend to the middle of genital segment (fig. *c*).

Abdomen 4-segmented; segments and furca with proportional lengths 44:17:14:9:16=100. Genital segment which is as long as wide, shows a sudden change in the continuity of the outline at the proximal two-fifths of the dorsal surface. Furcal rami as long as wide.

First antenna broken off. Second antenna with exopodite about as long as endopodite. First maxilla with 7 long and 2 short setae on outer lobe; third inner lobe with 3 setae and a conical process as shown in the figure (fig. *d*). Maxillipede has first basal joint about as long as the second; first joint has a lamellous process with a rounded tip on the posterior margin (fig. *e*).

First leg with 2-jointed exopodite which has no articulation between first and second joints. Second leg with 3-jointed exopodite and 2-jointed endopodite; the number of teeth on terminal spine of second to fourth legs are 20, 20 and 23 respectively. First basal joint of fourth leg bears about 16 lamellous bristles on the inner margin (fig. *f*).

Occurrence. One adult female from Sagami in the vertical hauls 1000–0 m, Nov. 1937.

Distribution. The species has been recorded from the west coast of Ireland, South Atlantic, Malay Archipelago, Indian Ocean, Denmark Strait, North-East Pacific.



Fig. 43. *Gaetanus pileatus* FARRAN.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, exopodite, endopodite and lobes of first maxilla; *e*, first leg; *f*, first basal joint of fourth leg; *g*, Male: fifth pair of legs.

Genus *Euchirella* GIESBRECHT, 1888

One species of this genus, *Euchirella amoena* GIESBRECHT, has been reported by MORI from Japanese waters. In the present collection I have found 9 species, of which two appear to be undescribed. The genus has the following characteristics: head usually separates from first thoracic segment; head with or without a crest; last thoracic segments fused; lateral corners of last thoracic segment rounded; rostrum usually present; abdomen 4-jointed in female; genital segment often asymmetrical; furcal rami about as long as wide; first antenna 23-jointed; endopodite of second antenna shorter than half the length of exopodite; second basal joint of first maxilla long; exopodite of first leg 2-jointed, those of the three following legs 3-jointed;

endopodite of first and second legs 1 jointed, those of third and fourth legs 3-jointed; first basal joint of female fourth leg has spines on the inner margin; fifth leg absent in female; male fifth pair of legs biramose on the right; left leg with a rudimentary endopodite. According to SARS the true member of the genus *Euchirella* are characterized by the reduction of joints of endopodite of second antenna, and by the reduction of the number of setae on endopodite of first maxilla.

Euchirella rostrata CLAUS

(Fig. 44, a-g)

Euchirella rostrata GIESBRECHT, 1892, p. 222; ESTERLY, 1905, p. 152; FARRAN, 1908, p. 38; SARS, 1935, p. 69; FARRAN, 1929, p. 234; WILSON, 1932, p. 55; JESPERSEN, 1934, p. 64; BRODSKY, 1950, p. 173.

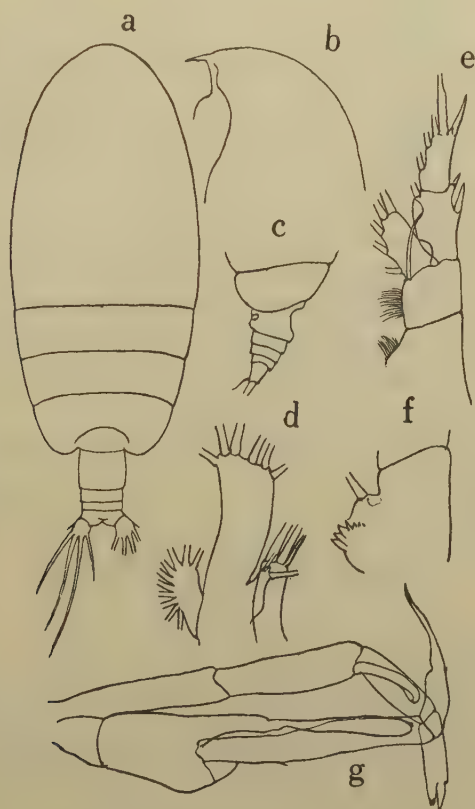


Fig. 44. *Euchirella rostrata* CLAUS.

a, Female: dorsal aspect; b, head, lateral aspect; c, last thoracic segment and abdomen, lateral aspect; d, exopodite and endopodite and lobes of first maxilla; e, first leg; f, first basal joint of fourth leg; g, fifth pair of legs.

Female. Length, 3.58 mm : cephalothorax, 2.95 mm ; abdomen, 0.63 mm. Cephalothorax robust (fig. *a*, *b*, *c*). Rostrum long and pointed. Abdomen 4-segmented ; segments and furca in the proportional lengths : 43:16:14:8:19=100. Genital segment has a small ventral process. Furcal rami about as long as wide.

First antenna 23-jointed, extends to distal end of third abdominal segment ; second joint is much shorter than joints 8-9. Second antenna has exopodite 2-times as long as endopodite. First maxilla has 3 setae on second inner lobe, 2 setae and a conical process on third inner lobe, 9 setae on outer lobe, 10 setae on exopodite, 4 setae on endopodite, 2 setae on second basal joint (fig. *d*).

First leg as figured by GIESBRECHT (fig. *e*). The number of teeth on terminal spine of exopodite of second to fourth legs are in the specimen examined :

	second	third	fourth
right leg	18	20	23
left leg	17	20	20

Fourth leg has triangular lamellous plates on first basal joint (fig. *f*).

Male. Length, 3.01 mm : cephalothorax, 2.38 mm ; abdomen, 0.68 mm. Cephalothorax slender. Head incompletely separates from first thoracic segment. Abdomen 4-segmented ; segments and furca in the proportional lengths : 26:20:17:13:7:17=100 ; furcal rami about as long as wide. First antenna extends to distal end of fourth abdominal segment ; joints 9-10, and 12-13 are partially fused. Second antenna with endopodite about 3/4-times as long as exopodite ; setae on second basal joint well developed. Fifth pair of legs differ from those of the other members of the genus : right leg does not form a complete prehensile organ ; left leg well developed (fig. *g*).

Occurrence. Common species among the genus, both from the surface and the deep waters of the Izu region.

Distribution. It is widely distributed in the Pacific, Atlantic, Mediterranean and California coast.

Euchirella pulchra (LUBBOCK)

(Fig. 45, *a-h*)

Euchirella pulchra GIESBRECHT, 1892, p. 233 ; A. SCOTT, 1909, p. 56 ; WILSON, 1932, p. 58 ; SEWELL, 1947, p. 80 ; VERVOORT, 1949, p. 20 ; BRODSKY, 1950, p. 175.

Female. Length, 3.47 mm : cephalothorax, 2.77 mm ; abdomen, 0.70 mm. Cephalothorax ovate ; forehead with a low crest ; frontal organ prominent (fig. *a*). Rostrum short (fig. *b*). Abdomen 4-segmented ; segments and furca in the proportional lengths : 52:15:13:5:15=100. Genital segment with a swelling on left side ; right side is indented (fig. *c*). Furcal rami about as long as wide.

First antenna 23-jointed, extends about to distal end of third abdominal segment ; joints are in the proportional lengths :

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	45	39	23	21	24	21	24	39	27	30	27	48	48	65	63	69
	18	19	20	21	22	23	24-25									
	63	69	56	50	47	42	42=1000.									

Second antenna with exopodite 2.8-times as long as endopodite; second joint of endopodite with 6+6 setae. Mandible with exopodite about as long as endopodite. First maxilla as in *Euchirella messinensis* (fig. d). Maxillipede with two basal joints of about equal lengths; second joint has a row of spinules on the proximal anterior margin.

In first leg outer edge spine of third joint of exopodite about as long as the joint itself. Terminal spine of second to fourth legs have 20, 19 and 19 teeth respectively.

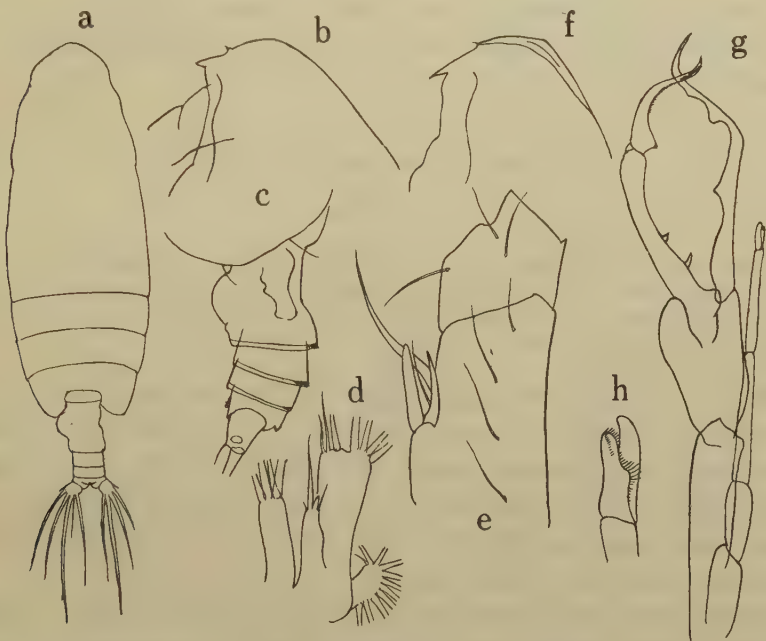


Fig. 45. *Euchirella pulchra* (LUBBOCK).

a. Female: dorsal aspect; b, head, lateral aspect; c, last thoracic segment and abdomen, lateral aspect; d, exopodite, endopodite and lobes of first maxilla; e, basal joints of fourth leg; f, Male: head, lateral aspect; g, fifth pair of legs; h, distal joint of exopodite of left fifth leg.

First basal joint of fourth leg has two subequal spines at the base of inner marginal seta, and scattered bristles on first and second basal joints (fig. e).

Male. Length, 3.06 mm: cephalothorax, 2.35 mm; abdomen, 0.71 mm; so abdomen is contained 3.3-times in the length of cephalothorax. Forehead with a low crest (fig. f). Last two thoracic segments are fused. Rostrum one-pointed. Abdomen

5-segmented; segments and furca in the proportional length: 25:23:19:19:2:12=100; distal margin of second and third segments are fringed with teeth.

First antenna extends about to distal end of third abdominal segment; joints 8 and 9 are fused; joints 12 and 13 are incompletely fused. First maxilla with 3 short and long setae on outer lobe, 10 setae on exopodite, and 4 setae on endopodite.

First leg with 3-jointed exopodite; second joint of exopodite has a minute outer edge spine; articulation between first and second joints clearly observed on the anterior surface. Second leg has a completely fused endopodite. Fourth leg has no spine on inner distal margin of second joint; inner edge spine of first joint of endopodite has an accessory spine. Fifth pair of legs as figured by GIESBRECHT (fig. *g, h*).

Occurrence. Two adult females from Sagami, Nov. 1937, and one male from Suruga, Dec. 1937, from deep waters.

Distribution. The species appears to have a wide distribution; it has been recorded from the Pacific, Atlantic, Malay Archipelago, San Diego region, and Mediterranean Sea.

Euchirella messinensis (CLAUS)

(Fig. 46, *a-g*)

Undinella messinensis CLAUS, 1863, p. 187; *Euchirella messinensis* GIESBRECHT, 1892, p. 232, t. 15, 36; A. SCOTT, 1909, p. 115; WOLFENDEN, 1911, p. 237; WITH, 1915, p. 122; SARS, 1925, p. 63; FARRAN, 1926, p. 253; SEWELL, 1929, p. 115; WILSON, 1932, p. 56; VERVOORT, 1949, p. 28; BRODSKY, 1950 p. 172.

Female. Length, 5.26 mm: cephalothorax, 4.07 mm; abdomen, 1.19 mm. Rostrum rather slender and acute, directs downwards (fig. *a, b*). Abdomen 4-segmented; segments and furca in the proportional lengths 49:18:12:6:15=100; dorsal protuberance of genital segment differs from the figure given by GIESBRECHT or SARS: it is much smaller and exceeds slightly the distal margin of genital segment, and situated rather on the middle of the dorsal surface (fig. *c*).

First antenna extends to the middle of second abdominal segment. Mouth parts and swimming legs as those of the foregoing species; endopodite of first maxilla has 4 setae. Fourth leg with two spines on the inner margin of first basal joint; terminal spine of the exopodite has 20 teeth (fig. *d*).

Male. Length, 4.62 mm: cephalothorax, 3.37 mm; abdomen, 1.25 mm; abdomen is contained 2.7-times in the length of cephalothorax. Forehead with low crest. Rostrum moderately long (fig. *e*). Lateral corners of last thoracic segment rounded. Second and third abdominal segments are furnished with coarse teeth on the distal margin.

First antenna 22-jointed, extends to the middle of second abdominal segment; proportional lengths of joints are as follows:

Joint	1	2	3	4	5	6	7	8-9	10	11	12-13	14	15	16	17
	37	45	22	22	25	22	30	40	27	30	75	47	70	42	75
	18	19	20	21	22	23	24-25								
	65	75	60	47	52	45	47=1000;								

joints 24-25 are 1.06-times as long as the 23rd; but they are 4-times in *Euchirella pulchra*; joint 18 is shorter than the 17th in the present specimen, but it is of about equal length in *E. pulchra*. Mouth parts and first to third swimming legs as those of *E. pulchra*. In fourth leg second basal joint has two minute spines near the inner distal margin. Fifth pair of legs resemble those of *E. pulchra*, but endopodite of right leg is longer than the combined lengths of two basal joints (fig. f, g).

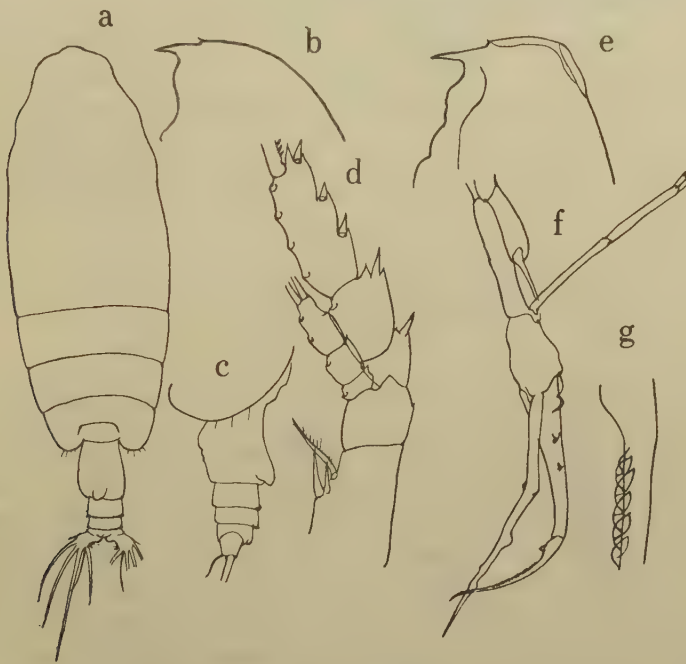


Fig. 46. *Euchirella messinensis* (CLAUS).

a, Female: dorsal aspect; b, head, lateral aspect; c, last thoracic segment and abdomen, lateral aspect; d, fourth leg; e, Male: head lateral aspect; f, fifth pair of legs; g, a part of distal joint of exopodite of right fifth leg.

Occurrence. One of the most common species in the deep water of Sagami and Suruga Bay.

Distribution. The species is widely distributed in the deep waters of the Pacific (San Diego), Atlantic, Indian Oceans, also from the Mediterranean and Malay Archipelago.

Euchirella venusta GIESBRECHT

(Fig. 47, a-g)

Euchirella venusta GIESBRECHT, 1892, p. 336; A. SCOTT, 1909, p. 57; FAFFAN, 1929, p. 237; SEWELL, 1947, p. 85; VERVOORT, 1949, p. 20.

Female. Length, 4.88 mm: cephalothorax, 3.88 mm; abdomen, 1.00 mm. General appearance as in *E. messinensis* (fig. a, b, c). Abdominal segments and furca in the proportional lengths 54:13:11:5:18=100. Genital segment asymmetrical; there is a remarkable protuberance on the left side of the segment; the proximal dorsal surface is hollowed; the ventral protuberance situated anterior to the genital opening is very prominent. Furcal rami about as long as wide.

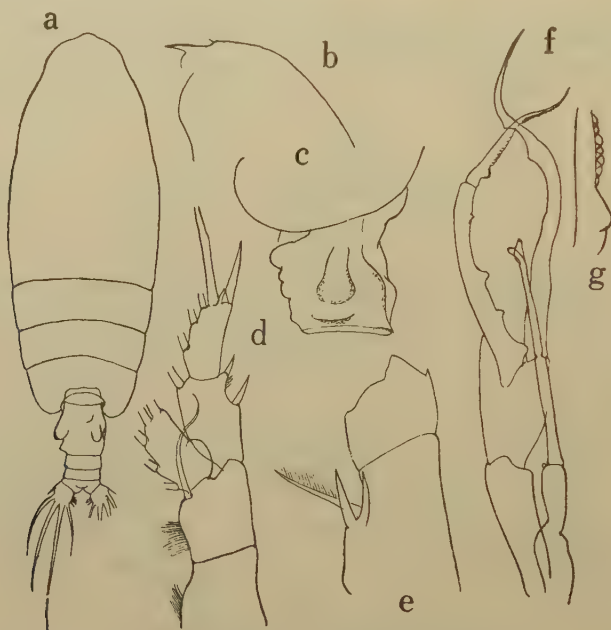


Fig. 47. *Euchirella venusta* GIESBRECHT.

a, Female: dorsal aspect; b, head, lateral aspect; c, last thoracic segment and genital segment, lateral aspect; d, first leg; e, basal joints of fourth leg; f, Male: fifth pair of legs; g, a part of distal joint of exopodite of right fifth leg.

First antenna 23-jointed, extends to distal end of genital segment; joints are in the proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	45	48	23	20	23	20	23	36	24	28	28	48	50	68	64	72
	18	19	20	21	22	23	24-25									
	64	68	60	48	44	38	48=1000.									

Second antenna with exopodite about 3.4-times as long as endopodite. Mandible blade is robust and has a long inner edge seta. First maxilla has 11 setae on exopodite, 4 setae on endopodite, 6 setae on outer lobe, 3 setae on second basal joint. Second maxilla without characteristic features. Maxillipede as that of *E. messinensis*; outer margin of second basal joint has two swellings on the distal half of the joint.

First leg has 2 outer edge spines on outer margin of first joint of exopodite as in other members of the genus (fig. *d*).

Terminal spine of exopodite of second to fourth legs have 20, 21 and 20 teeth respectively. Fourth leg has two spines reaching the proximal margin of second basal joint on the inner margin of first basal joint at the base of inner marginal seta (fig. *e*).

Male. Length, 3.70 mm: cephalothorax, 2.95 mm; abdomen, 0.75 mm. General appearance as in the female. Head without crest. First antenna reaches back to distal margin of first abdominal segment. Fifth pair of legs closely resemble those of *E. messinensis* (fig. *f*, *g*).

Occurrence. Two adult females and a male from Suruga in the vertical hauls 1000–0 m, July, 1937.

Distribution. The species has been recorded from the Atlantic, and Malay Archipelago.

Euchirella intermedia WITH

(Fig. 48, *a–f*)

Euchirella intermedia WITH, 1915, p. 124; SARS, 1925, p. 68; VERVOORT, 1947, p. 28.

Female. Length, 6.19 mm: cephalothorax, 5.25 mm; abdomen, 0.94 mm. Cephalothorax ovate. Frontal margin of head produced triangularly. Articular membrane between head and first thoracic segment faintly visible; last two thoracic segments incompletely fused. (fig. *a*). Lateral corners of last thoracic segment rounded (fig. *c*). Rostrum slightly curved posteriorly; rostral spine slender (fig. *b*).

Abdomen is contained 5.6-times in the length of cephalothorax; segments and furca in the proportional lengths 51:12:8:15:13=100. Genital segment asymmetrical: the left side is in dorsal view more inflated about the middle of the segment; lateral distal corner of the left side has a process which is concave at the apical portion (fig. *d*).

First antenna 24-jointed, extends to distal end of furca. First maxilla has 5 setae on endopodite, 3 setae on second basal joint, of which two are very short (fig. *e*).

In fourth leg first basal joint has a single spine extending to the distal margin of the joint on the inner margin at the base of the inner marginal seta (fig. *f*).

Remarks. The species is easily recognised by the shape of genital segment, and a single strong spine on first basal joint of fourth leg. WITH's specimen measured 5.66 mm, SARS' 6.20 mm.

Occurrence. One adult female from Suruga in the depth 400–200m, March, 1940.

Distribution. The species has been recorded from the North Atlantic.

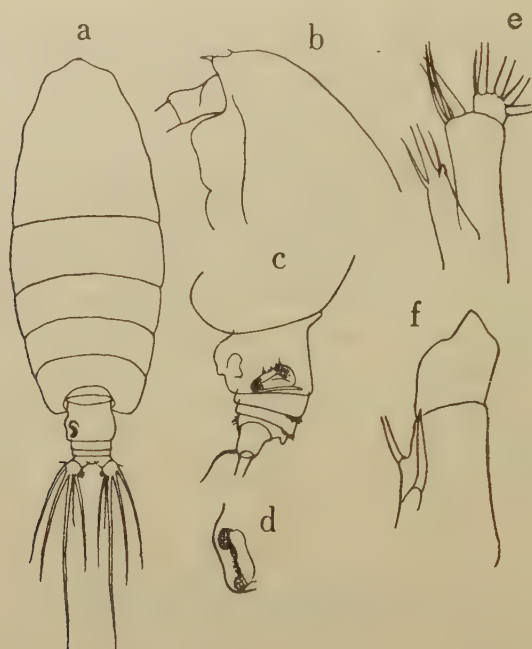


Fig. 48. *Euchiarella intermedia* WITH.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, protuberance on left margin of genital segment; *e*, endopodite and lobes of first maxilla; *f*, basal joints of fourth leg.

Euchiarella trigrada sp. nov.

(Fig. 49, *a-h*)

Female. Length, 5.23 mm: cephalothorax, 4.33 mm; abdomen, 0.90 mm; the greatest width of cephalothorax, 1.70 mm. General appearance as in *E. intermedia* WITH (fig. *a*). Head and first thoracic segment separate. Rostrum directs straight forwards; rostral spine moderately long (fig. *b*).

Abdomen 4-segmented; segments and furca in the proportional lengths 60:10:8:6:16=100. Genital segment which is as deep as wide is shorter than wide; the segment is in dorsal view slightly asymmetrical; there are on the left side 3 lamellous processes of which the distal two are broad at the base; there is a blunt process on the right side; genital area as that of *E. intermedia*. Furcal rami shorter than wide.

First antenna 23-jointed, reaches back to distal end of furca; joints are in the following proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	39	45	26	23	26	26	26	49	34	34	30	49	52	52	52	56
	18	19	20	21	22	23	24-25									
	67	75	56	45	49	38	52=1000;									

joints 3, 7, 9, 14 and 18 have each a long seta; aesthetascs are found on joints 9, 12, 14 and 19. Second antenna with exopodite about 3.7-times as long as endopodite; first basal joint has a tuft of hairs on the posterior surface (fig. *d*). First maxilla as



Fig. 49. *Euchiarella trigrada* sp. nov.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and genital segment; *d*, second antenna; *e*, maxillipede; *f*, first leg; *g*, outer margin of exopodite of second leg; *h*, inner margin of basal joints of fourth leg.

that of *E. messinensis*; second basal with 3 setae, endopodite with 4 setae, exopodite with 11 setae. Second maxilla as that of *E. rostrata*. Maxillipede with sinuate anterior margin on second basal joint (fig. *e*).

First leg as that of other members of the genus (fig. *f*). Second leg has strong outer edge spines on joints of exopodite (fig. *g*). Terminal spines of exopodite of

second to fourth legs have each 20 teeth. Fourth leg has two subequal spines on posterior surface of first basal joint (fig. *h*).

Remarks. The present specimen closely resembles *E. intermedia* WITH but genital segment and first basal joint of fourth leg are quite different from the former.

Occurrence. Five adult females from Suruga in the hauls 1000-0 m, Nov. 1937.

Euchirella areata sp. nov.

(Fig. 50, *a-h*)

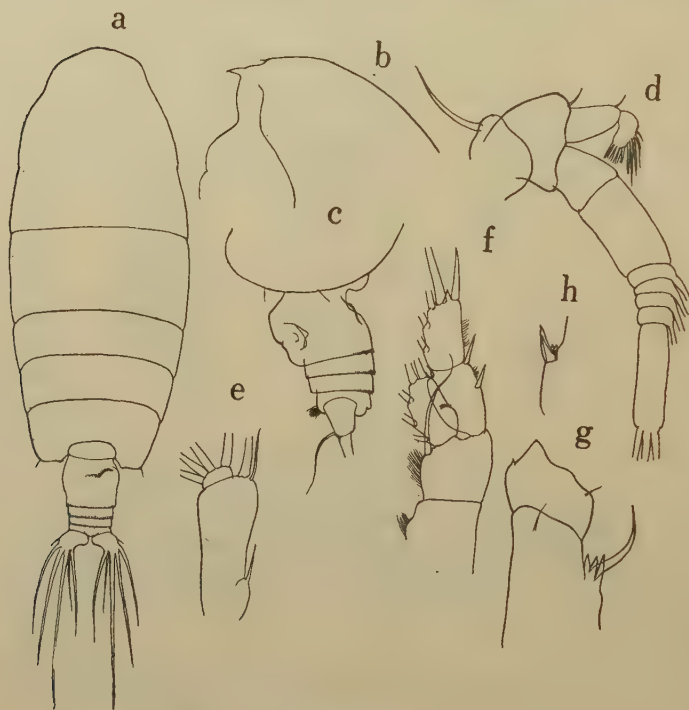


Fig. 50. *Euchirella areata* sp. nov.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, second antenna; *e*, endopodite and second basal joint of first maxilla; *f*, first leg; *g*, basal joints of fourth leg; *h*, inner margin of first basal joint of fourth leg.

Female. Length, 3.75 mm : cephalothorax, 3.06 mm ; abdomen, 0.69 mm. Cephalothorax oblong ovate. Head separates from first thoracic segment; last two thoracic segments are fused (fig. *a*). Lateral corners of last thoracic segment rounded (fig. *c*). Rostrum small. Frontal organ prominent (fig. *b*).

Abdomen 4-segmented; segments and furca in the proportional lengths 51:13:10:8:18=100. Genital segment asymmetrical; the right side is more inflated on the

lateral margin; dorsal surface is concave at the proximal half, and there is a slight protuberance on the periphery of the hollow on the right side.

First antenna 24-jointed, exceeds distal end of furca by distal two joints; joints are in proportional length:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	50	36	23	23	23	18	23	36	27	27	27	48	50	66	68	70
	18	19	20	21	22	23	24	25								
	66	68	59	50	46	41	41	14=1000;								

joints 8 and 9 are separate on the posterior margin. Second antenna has a very short endopodite about $1/5$ the length of exopodite; distal joint of endopodite has 10 setae (fig. *d*). Mandible has exopodite a little longer than endopodite (10:8). In first maxilla endopodite has 4 setae, second basal has 2 setae, of which the proximal one is very short (fig. *e*). Second maxilla and maxilliped as those of *E. rostrata*.

First leg has 2-jointed exopodite; first joint of exopodite has 2 outer edge spines (fig. *f*). Second and third legs as those of *E. rostrata*. In fourth leg first basal joint has on the inner face spines of which the outer one is notched at the apex (fig. *g*); the spine of the left fourth leg was broken off, but the indication of bifurcation is slightly observed (fig. *h*).

Remarks. The specimen resembles *E. rostrata*, but differs from it in the followings: large size, small rostrum, shape of genital segment, structure of second antenna, and spine of the inner face of first basal joint of fourth leg.

Occurrence. One adult female from Sagami in the hauls 1000-0 m, Oct. 1938.

Euchirella curticauda GIESBRECHT

(Fig. 51, *a-g*)

Euchirella curticauda GIESBRECHT, 1892, p. 233, t. 15, 36; A. SCOTT, 1909, p. 55; WOLFENDEN, 1911, p. 236; WITH, 1915, p. 118; SARS, 1925, p. 72; FARRAN, 1926, p. 251; SEWELL, 1929, p. 109; WILSON, 1932, p. 59; JESPERSEN, 1934, p. 64; BRODSKY, 1950, p. 176.

Female. Length, 3.50 mm; cephalothorax, 3.00 mm; abdomen, 0.50 mm. Line of fusion between head and thoracic segment faintly observed (fig. *a*). Head with median crest; frontal organ prominent; rostrum very short (fig. *b*). Abdomen 4-segmented; segments and furca in the proportional length 52:8:12:8:22=100. Genital segment has lateral projections on each side of genital opening when viewed from the ventral (fig. *c*). Furcal rami 1.6-times as wide as long.

First antenna extends to distal end of last thoracic segment; joint 2 is longer than joints 8-9, which are about as long as joint 13th or 14th. Second antenna with exopodite 4 times as long as endopodite; first joint of exopodite with a process on the inner margin. First maxilla with 9 setae on outer lobe, 11 setae on exopodite, 3 setae on endopodite, 3 setae on second basal, 4 setae on second inner lobe, 4 setae

on third inner lobe. Second maxilla robust and stout. Maxillipede has on first basal joint a knob-like process on the anterior surface near the distal margin.

Second leg with a strong outer edge spine on second joint of exopodite; terminal spine of exopodite with 20 teeth (fig. *d*). Fourth leg with 24 teeth on terminal spine of exopodite; first basal joint has 11 spines on the left, and 8 on the right at the base of inner marginal seta (fig. *e*).

Male. Length, 3.14 mm: cephalothorax, 2.45 mm; abdomen, 0.70 mm. General appearance as in the female. Rostrum more distinct. Abdominal segments and furca in the proportional lengths 27:22:19:16:5:11=100. Furcal rami shorter than wide. First antenna extends to distal end of thoracic segment; joints are in the following proportional lengths:

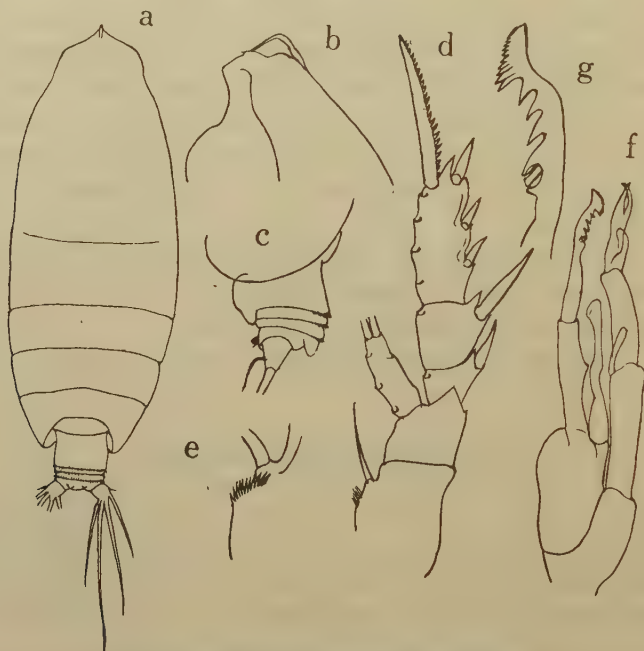


Fig. 51. *Euchirella curticauda* GIESBRECHT.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, second leg; *e*, inner margin of first basal joint of fourth leg; *f*, Male: fifth pair of legs; *g*, distal joint of exopodite of right fifth leg.

Joint	1	2	3	4	5	6	7	8-9-10	11	12	13	14	15	16	17
	66	63	26	23	26	20	30	76	26	70	46	63	60	63	52
	18	19	20	21	22	23	24-25								
	53	60	53	43	46	41	50=1000;								

joints 20 and 21 are fused on the right side. Second antenna with endopodite about

3/4 as long as exopodite. First leg with a slender exopodite. Fifth pair of legs as figured by SARS (fig. *f*, *g*).

Occurrence. One adult female from Suruga, Dec. 1937, and two males from Sagami, Nov. 1937, in the vertical hauls from 1000 m to the surface.

Distribution. The species has a wide distribution in the Pacific, Atlantic, Indian Oceans, Mediterranean Sea and Malay Archipelago.

Euchirella bitumida WITH

(Fig. 52, *a-e*)

Euchirella bitumida WITH, 1915, p. 131; SARS, 1925, ; FARRAN, 1926, p. 253; VERVOORT, 1949, p. 35.

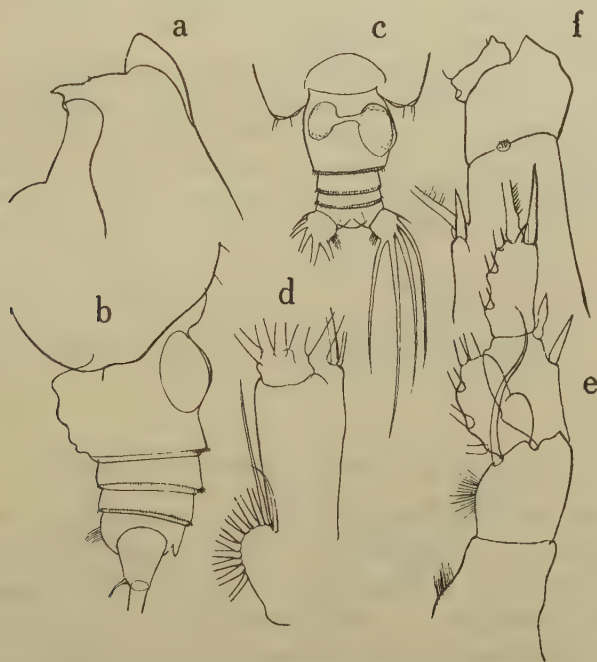


Fig. 52. *Euchirella bitumida* WITH.

a, Female: head, lateral aspect; *b*, last thoracic segment and abdomen, lateral aspect; *c*, last thoracic segment and abdomen, dorsal aspect; *d*, exopodite and endopodite of first maxilla; *e*, first leg; *f*, basal joints of fourth leg.

Female. Length, 6.07 mm: cephalothorax, 4.95 mm; abdomen, 1.12 mm; so abdomen is contained 4.4-times in the length of cephalothorax. Head is produced into helmet-shaped crista and fused with first thoracic segment (fig. *a*, *c*). Lateral corners of last thoracic segment rounded (fig. *b*). Rostrum short.

Abdomen 4-segmented; segments and furca in the proportional length 50:15:11:12:12=100. Genital segment has two protuberances: the one on the right side is better marked than that on the left; the ventral side of the segment is bluntly produced near the proximal part. First three segments are fringed with fine teeth on the distal border. Furcal rami wider than long.

First antenna extends nearly to distal end of abdomen; proportional lengths of the distal joints are as follows:

Joint	15	16	17	18	19	20	21	22	23	24-25
	22	21	23.5	20	22	18	14	14	11.5	14.

Second antenna with exopodite 3.6-times as long as endopodite. First maxilla with 7 setae on exopodite, 4 setae on endopodite, 3 setae on second basal (fig. *d*). Second maxilla very stout; spine on fifth lobe has peculiar rows of spinules. Maxillipede has second basal joint 1.3-times as long as the first, and is more than 2-times as long as the combined length of joints of endopodite.

In first leg first and second joints of exopodite completely fused; outer edge spine of third joint of exopodite is equal in length to the joint itself (fig. *e*). Second leg with 1-jointed endopodite. In fourth leg inner margin of first basal joint has a moderately long spine at the base of the inner marginal seta; there is a spot furnished with minute spinules on the line of demarcation between first and second basal joints (fig. *e*). The number of teeth on terminal spine of second leg is 21, and that of third leg 20.

Occurrence. One adult female from Suruga, Dec. 1937, and two females from Sagami, Nov. 1937 in the vertical hauls 1000-0 m.

Distribution. The species, though unrecorded from the Indian seas, appears to be widely distributed in the deep waters of the oceans.

Genus *Chirundina* GIESBRECHT, 1895

There has only one species *Chirundina streetsi* GIESBRECHT been known until SEWELL (1929) reported the occurrence of the second species, *Chirundina indica*, from the Indian waters; one of which appeared in the Izu region. The genus, closely allied to *Euchirella* and *Undeuchaeta*, has the generic characters in the following: head has a crest; rostrum one-pointed and well developed; lateral corners of last thoracic segment produced backwards into blunt processes; endopodite of second antenna about half the length of exopodite; the spinulation of endopodite of first maxilla not reduced; exopodite of first leg 2-jointed; fourth leg without spine on the inner margin of first basal joint.

Chirundina streetsi GIESBRECHT

(Fig. 53, *a-i*)

Chirundina streetsi GIESBRECHT, 1895, p. 250; FARRAN, 1908, p. 37; A. SCOTT, 1909, p. 43, pl. 7; WITH, 1915, p. 41; SARS, 1925, p. 77; SEWELL, 1947, p. 95; BRODSKY, 1950, p. 180.

Female. Length, 5.01 : cephalothorax, 3.95 mm ; abdomen, 1.06 mm. Head with a median crest (fig. *a*, *b*). Rostrum one-pointed and strong (fig. *d*). Lateral corners of last thoracic segment produced triangularly with each a pointed knob at the apex (fig. *c*).

Abdomen 4-segmented ; segments and furca in the proportional lengths $48:19:12:5:16=100$. Genital segment is swollen toward the distal end ; ventral surface of the segment has a moderate protuberance just above genital opening. Posterior margin of third segment is fringed with fine teeth. Furcal rami about as long as wide.

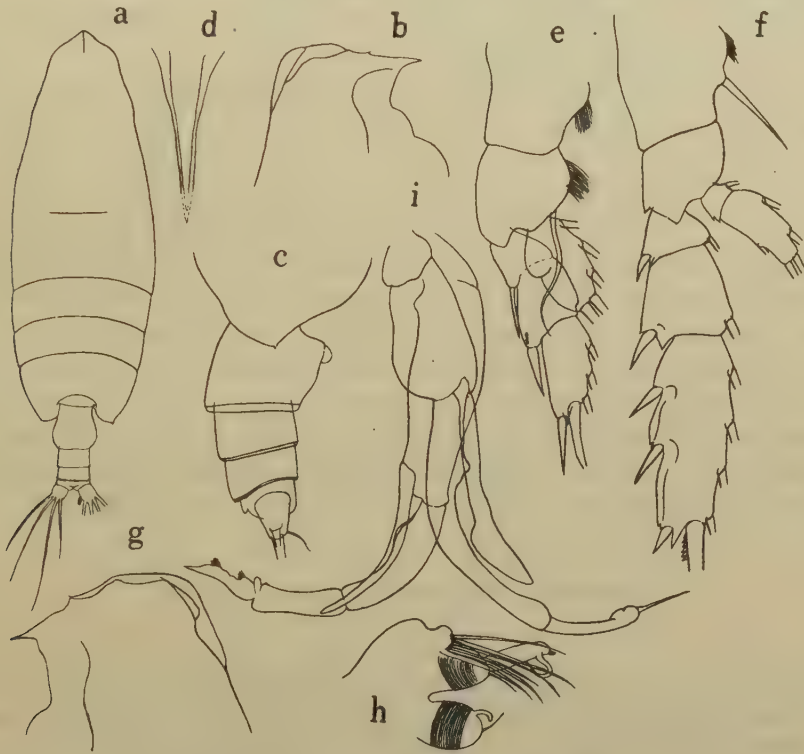


Fig. 53. *Chirundina streetsi* GIESBRECHT.

a, Female: dorsal aspect ; *b*, head, lateral aspect ; *c*, last thoracic segment and abdomen, lateral aspect ; *d*, rostrum, anterior aspect ; *e*, first leg ; *f*, second leg ; *g*, Male: head, lateral aspect ; *h*, second maxilla ; *i*, fifth pair of legs.

First antenna 23-jointed, exceeds slightly distal end of furca ; joint 8-9, and 24-25 are fused. Second antenna with exopodite 1.6-times as long as endopodite.

In first leg exopodite incompletely 3-jointed ; the articular membrane between first and second joints is observed distinctly on the anterior surface (fig. *e*). In second leg first joint of endopodite has an accessory tooth (fig. *f*).

Male. Length, 4.81 mm : cephalothorax, 3.50 mm ; abdomen, 1.31 mm. Head has

a median crest (fig. *g*). Lateral corners of last thoracic segment rounded. Abdomen 5-segmented; segments and furca in the proportional length $23:32:27:20:7:11=100$; second to fourth segments are fringed with fine teeth on the posterior margin.

First antenna extends to the middle of the second abdominal segment; the left one is 21-jointed; the right 20-jointed. Maxillae and maxillipede are reduced; second maxilla as shown in the figure (fig. *h*).

First leg with 3-jointed exopodite and 1-jointed endopodite. Second leg with 33 teeth on the terminal spine of exopodite. Third leg with 24 teeth. Fourth leg with 33 teeth. Fifth pair of legs as figured by Sars (fig. *i*).

Occurrence. Two females from Sagami, one female and two males from Suruga, Dec. 1937, in the vertical hauls 1000-0 m.

Distribution. It is widely distributed in the Pacific, Atlantic, but has not been reported from the Indian seas.

Genus *Pseudochirella* G. O. Sars, 1920

The genus was created to accommodate a number of species that were intermediate in character between *Euchirella* and *Undeuchaeta*. The genus resembles *Euchirella* in general appearance, and, especially, in having spines on inner margin of first basal joint of fourth leg. The well-developed endopodite of second antenna shows a close relationship to *Undeuchaeta*. First maxilla has more increased number of setae on endopodite than in *Euchirella*. First and second joints of exopodite of first leg are incompletely fused; endopodite of the second leg incompletely fused. Three species were found in the collection, of which two appear to be undescribed.

Pseudochirella pustulifera G. O. Sars

(Fig. 54, *a-g*)

Chirundina pustulifera WITH, 1915, p. 145; *Pseudochirella pustulifera* Sars, 1925, p. 85, pl. 24; WILSON, 1932, *Chirundina pustulifera* WILSON, 1932, p. 49; *Pseudochirella pustulifera* JESPERSEN, 1934, p. 65.

Female. Length, 6.26 mm: cephalothorax, 4.95 mm; abdomen, 1.31 mm. Head incompletely separates from first thoracic segment; fourth and fifth thoracic segments are separate (fig. *a*). Rostrum strong, directs backwards; frontal organ prominent (fig. *b*). Lateral corners of the last thoracic segment rounded (fig. *c*).

Abdomen 4-segmented; segments and furca in the proportional length $43:19:14:10:14=100$. Genital segment is of characteristic shape: remarkable protuberance on each side of the segment; they are more prominent than those figured by previous authors; second segment is setose on the ventral surface; distal margin of second and third segments fringed with fine teeth; furcal rami as long as wide.

First antenna 23-jointed, extends to distal end of third abdominal segment; joints

8-9, 13-14 are of about equal lengths; joint 19 is the longest. Second antenna with exopodite about 1.6-time as long as endopodite (43:26); posterior surface of first basal joint has a tuft of hairs. Mandible robust, carries 3 setae on second basal joint; biting part has strong teeth. First maxilla has the following number of setae; exopodite has 11 setae, outer lobe has 7+2 setae; first joint of endopodite has 4 setae; second joint has 5 setae; third has setae; second basal 5 setae; third inner lobe has 4 setae and a conical process; second inner lobe has 5 setae. Second maxilla very robust. Maxillipede has a small conical process on fourth lobe of first basal.

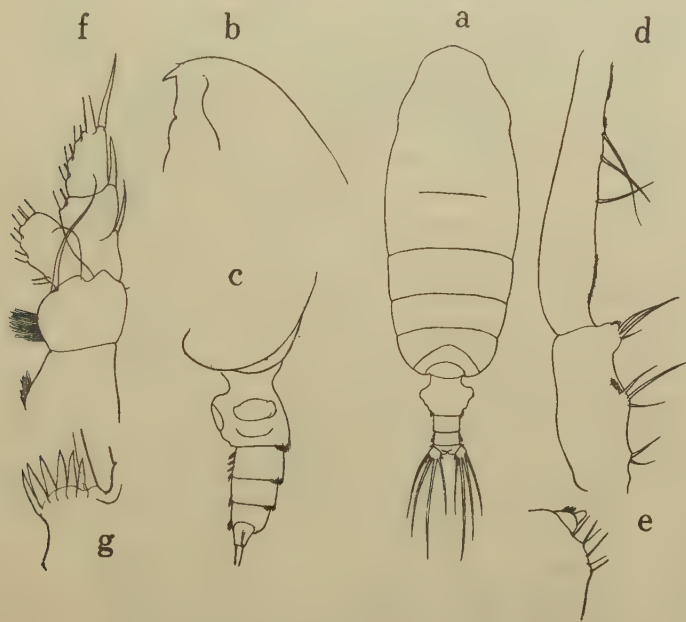


Fig. 54. *Pseudochirella pustulifera* G. O. SARS.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, basal joints of maxillipede; *e*, distal margin of first basal joint of maxillipede; *f*, first leg; *g*, inner margin of first basal joint of fourth leg.

In first leg articulation between first and second joint of exopodite is distinct only on the anterior surface. Articulation between first and second joints of endopodite of second leg is observed on the anterior surface; terminal spine of exopodite has about 74 teeth. Fourth leg has six fairly long spines on the inner margin of first basal joint. Some of mouth appendages and swimming legs are of crimson colour.

Occurrence. Two adult females from Sagami, Nov. 1937, and one female from Suruga, Dec. 1937, in the vertical hauls 1000-0 m.

Distribution. It has been recorded only from the North Atlantic. This is the first record from Japanese waters.

Pseudochirella polyspina BRODSKY

(Fig. 55, a-f)

Pseudochirella polyspina BRODSKY, 1950, p.

Female. Length, 6.28 mm: cephalothorax, 4.90 mm; abdomen, 1.38 mm; the greatest width of cephalothorax, 2.00 mm. Head separates indistinctly from first

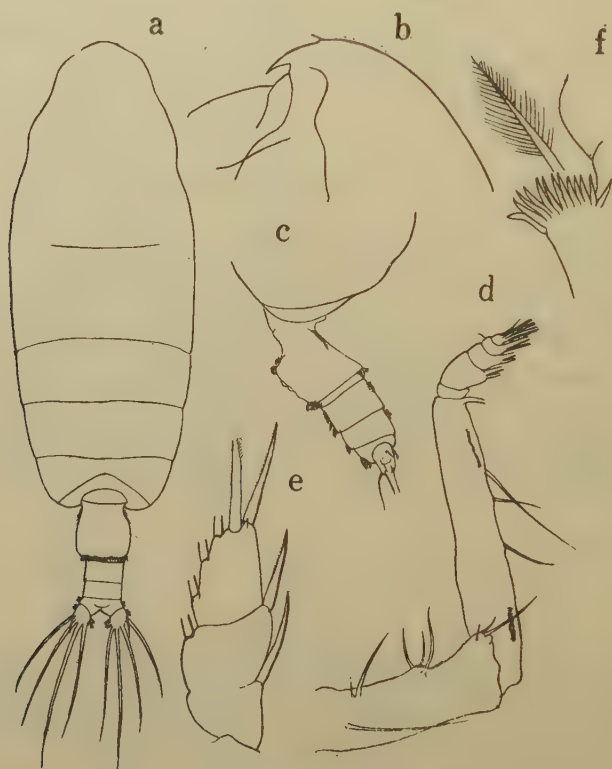


Fig. 55. *Pseudochirella polyspina* BRODSKY.

a, Female: dorsal aspect; b, head, lateral aspect; c, last thoracic segment and abdomen, lateral aspect; d, maxilliped; e, exopodite of first leg; f, inner margin of first basal joint of fourth leg.

thoracic segment; last two thoracic segments separate. Lateral corners of last thoracic segment rounded (fig. a, b). Rostrum moderately long and strong, directs posteriorly. Abdomen 4-segmented; segments and the furca in the proportional lengths 47:20:13:7:13=100. Genital segment is furnished with hairs on the lateral proximal and

distal margins, and also on the ventral side at the base of genital opening, and on the distal ventral margin. Furcal rami about as long as wide (fig. *c*).

First antenna 23-jointed, extends to distal end of furca; joints are in the following proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	37	46	31	31	34	31	31	50	27	31	27	43	43	50	53	56
	18	19	20	21	22	23	24-25									
	50	65	62	43	50	53	56=1000;									

first joint has a swelling on the posterior margin. Second antenna has exopodite 3/5 as long as endopodite. Mandible has a strong biting part, the tooth on the outer margin is long. First maxilla has the following spinulation: 7 long and 2 short setae on outer lobe; 11 setae on exopodite; 15 setae on endopodite; 5 setae on second basal joint; 4 setae and a small process on third inner lobe; 5 setae on second inner lobe. Second maxilla as that of *P. pustulifera*. Maxillipede has second basal joint 1.5 times as long as the first; anterior distal margin of the joint has a row of spinules, and a double rows of spinules on the proximal margin (fig. *d*).

First leg has a slender outer edge spine on the joints of the exopodite; first and second joints are incompletely fused (fig. *f*). Second and third legs have no interesting features. Fourth leg has 13 spines on inner margin of first basal.

Remarks. The present specimen, though a little larger than that described by BRODSKY, agrees quite well with his *P. polyspina* taken from the Far-Eastern seas. This is the same species to which I gave a new *P. dura* in the systematic list of the pelagic copepods of the Izu region published in "Records of Oceanographic Works in Japan", N. S., Vol. 1, No. 1, 1953.

Pseudochirella tuberculata sp. nov.

(Fig. 56, *a-g*)

Female. Length 6.10 mm: cephalothorax, 5.00 mm; abdomen, 1.10 mm. Head separates distinctly from first thoracic segment; fourth and fifth thoracic segments incompletely separate (fig. *a, b*). Lateral corners of last thoracic segment asymmetrical: left side is evenly rounded, but right side carries a rounded process on the postero-lateral margin; lateral corners are furnished with short hairs (fig. *c, d*). Rostrum strong, directs somewhat posteriorly.

Abdomen 4-jointed; segments and furca in the proportional lengths 49:16:11:6:18=100. Genital segment wider than long, slightly asymmetrical: left side is more inflated than the right. Furcal rami about as long as wide. Abdominal segments and furca very setose.

First antenna 23-jointed, extends to distal end of genital segments; proportional lengths of joints as follows:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	22	26	26	26	30	31	31	53	30	32	30	50	45	55	58	61
	18	19	20	21	22	23	24-25									
	53	74	70	45	53	53	56=1000.									

Second antenna has endopodite slightly longer than half the length of exopodite (19:10). Mandible blade very strong. First maxilla has 5 setae on second basal joint, 15 setae on endopodite, 11 setae on exopodite, 7 long and 2 short setae on outer lobe. Maxillipede has strong setae on fourth and fifth lobes of first basal joint; basal joints and exopodite are in proportional length 42:74:23.

First leg has the joints of exopodite fused between the first and second; outer edge spines slender and long (fig. *e*). Second leg has 2-jointed endopodite articulated

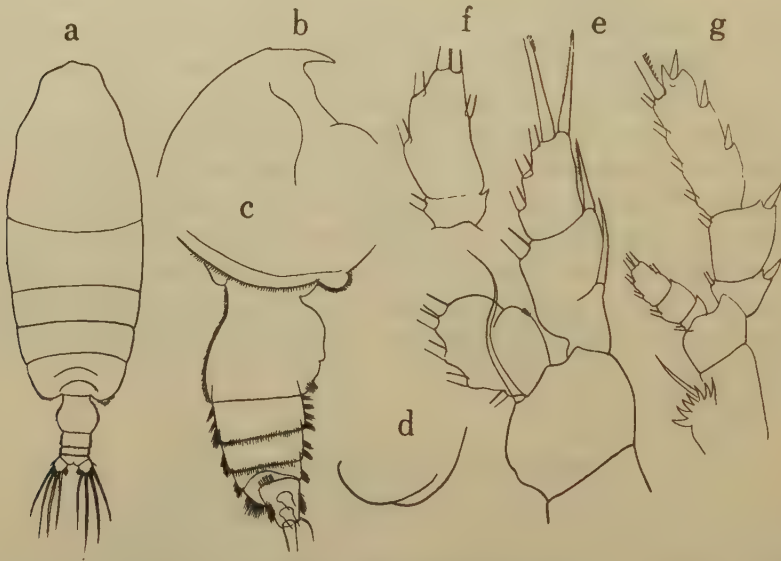


Fig. 56. *Pseudochirella tuberculata* sp. nov.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, last thoracic segment, left side, lateral aspect; *e*, first leg; *f*, endopodite of second leg; *g*, fourth leg.

on the anterior surface (fig. *f*). Fourth leg has 7 long spines on the inner margin of first basal joint at the base of inner marginal seta (fig. *g*).

Remarks. The present specimen is quite different from the other members of the genus in the shape of genital segment and lateral corners of the last thoracic segment.

Occurrence. One adult female from Suruga, July, 1937, and one female from Sagami, Nov. 1937, in the hauls 1000-0 m.

Genus *Chirundinella* gen. nov.

Definition. Cephalothorax elongate ovate; head separates from first thoracic segment; fourth and fifth thoracic segments are fused; head has a median crest; rostrum one-pointed. Abdomen 4-jointed in female; outer marginal seta of furca short; appendicular seta very long. First antenna 24-jointed, joints 8-9 are fused, joints 24 and 25 are separate. Second antenna has exopodite which is longer than endopodite. Mandible has a small endopodite which is slightly longer than half the length of exopodite; biting part robust. First maxilla has 4 setae on second basal joint, 10 setae on endopodite. Second maxilla and maxillipede resemble those of *Pseudochirella*. First leg has 3-jointed exopodite and 1-jointed endopodite. Second leg has 3-jointed exopodite and 2-jointed endopodite. Third and fourth legs have each 3-jointed exopodite and endopodite; fourth leg has a row of bristles on inner margin of first basal joint. Fifth leg absent in the female. Male unknown.

Chirundinella cara sp. nov.(Fig. 57, *a-j*)

Female. Length, 7.44 mm; cephalothorax, 6.00 mm; abdomen, 1.44 mm; abdomen is contained 4.2-times in the length of cephalothorax (fig. *a*). Lateral corners of last thoracic segment rounded (fig. *c*). Rostrum as in *Chirundina*; the basal part robust, and directs somewhat posteriorly (fig. *b*).

Abdomen 4-segmented; segments and furca in the proportional lengths 42:15:12:17:14=100. Genital segment produced moderately below; first three segments are fringed with serrated plates (fig. *c*). Furcal rami about as long as wide (12:11); appendicular seta about 3-times as long as second inner seta (fig. *d*).

First antenna 24-jointed, exceeds distal end of furca by distal three joints; joints are in the following proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	67	30	19	19	20	20	23	47	21	23	26	38	40	53	51	55
	18	19	20	21	22	23	24	25								
	57	74	72	57	80	59	40	20=1000;								

joints 3, 7, 9, 18 and 21 are each furnished with a long seta. Second antenna has endopodite a little more than half the length of exopodite (33:52). Mandible has endopodite 3/5 the length of exopodite (25:42); second basal joint has two inner marginal setae (fig. *e*). First maxilla has 4 setae on second basal joint, 10 setae on the endopodite. The number of setae on second basal joint and endopodite of first maxilla in *Chirundina*, *Pseudochirella* and *Undeuchaeta* are as follows:

	second basal joint	endopodite
<i>Chirundina</i>	5	14
<i>Pseudochirella</i>	5	14-15
<i>Undeuchaeta</i>	5	10

Thus the present specimen agrees with *Undeuchaeta* in the number of setae on endopodite. Second maxilla as that of *Chirundina streetsi*, but the strong seta on fifth lobe appears to be more slender than that of *C. streetsi* (fig. f). Maxillipede has a slender second basal joint; two proximal setae on second basal joint are very closely set

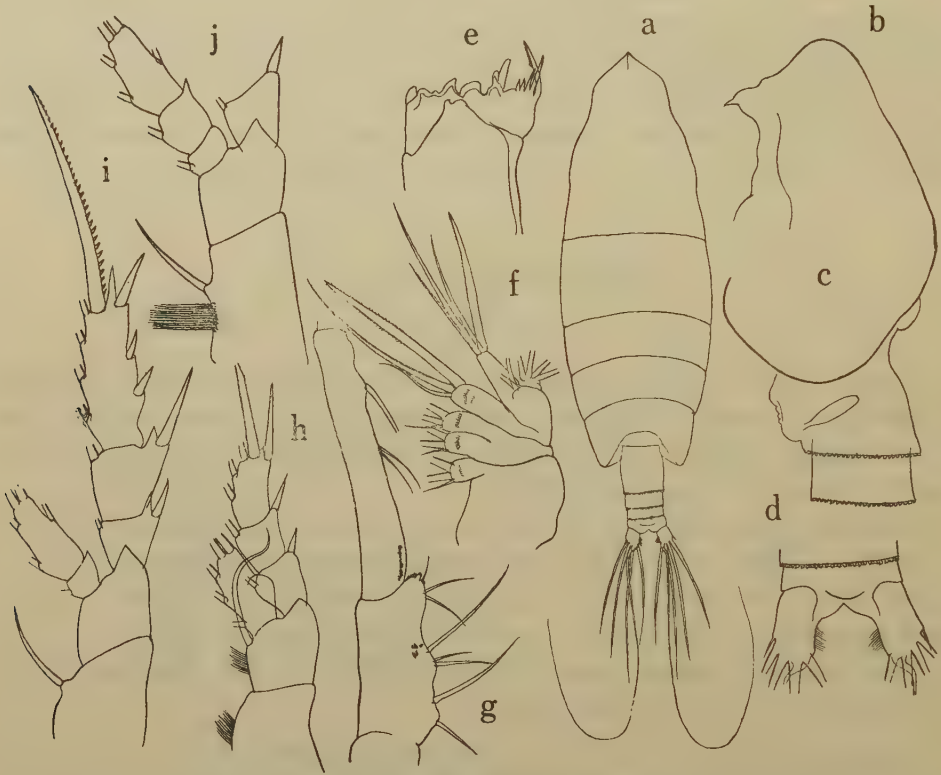


Fig. 57. *Chirundinella cara* sp. nov.

a, Female: dorsal aspect; b, head, lateral aspect; c, last thoracic segment and genital segment, lateral aspect; d, anal segment and furca, dorsal aspect; e, cutting edge of mandible; f, second maxilla; g, basal joints of maxillipede; h, first leg; i, second leg; j, endopodite and basal joints of fourth leg.

together; there is a row of spinules along the proximal anterior margin of second basal joint (fig. g).

First leg has 3-jointed exopodite; line of demarcation between first and second joints of exopodite is distinct; outer edge spine of third joint of exopodite is the longest (fig. h). In second leg outer edge spine of second joint of exopodite reaches

the level of proximal spine of third joint; terminal spine as long as the combined lengths of the three joints of the exopodite taken together, and has 30 serrations; endopodite distinctly 2-jointed (fig. *i*). Third leg has 3-jointed exopodite and endopodite; terminal spine has 24 serrations. In fourth leg first basal joint has a row of long bristles, about ten in number, on the inner margin near the base of inner marginal seta; terminal spine of exopodite has 22 serrations (fig. *j*).

Remarks. The present specimen has a general resemblance to *Chirundina*, and also, in some respects to *Undeuchaeta* and *Pseudochirella*, but appendicular seta, the number of setae on second basal joint and endopodite of first maxilla, and the structure of first and second legs, and also in fourth leg, are the characteristic features which distinguish the species from the other members of the closely allied genus.

Occurrence. One adult female from Sagami in a haul 1000–0 m, Nov. 1938.

Genus *Undeuchaeta* GIESBRECHT, 1888

Up to the present time I have detected three species of the genus: *Undeuchaeta major* GIESBRECHT, *U. plumosa* (LUBBOCK) and the other species which appears to be undescribed. The genus is closely allied to *Chirundina*: head fused with thoracic segment; last two thoracic segments are fused; head with or without crest; last thoracic segment bluntly produced in female, rounded in the male; rostrum one-pointed; furcal rami short, appendicular seta short; first antenna 23-jointed; endopodite of second antenna more than half the length of exopodite; exopodite of first maxilla short, the number of seta on endopodite unreduced; second maxilla as in *Aetideus*; endopodite of maxillipede very short; endopodite of second leg 1-jointed; fifth leg absent in female. In male exopodite of first leg 3-jointed; fifth pair of legs biramose.

Undeuchaeta plumosa (LUBBOCK)

(Fig. 58, *a-m*)

Undeuchaeta minor GIESBRECHT, 1892, p. 228; ESTERLY, 1905, p. 149; FARRAN, 1905, p. 198; FARRAN, 1908, p. 37; *Undeuchaeta plumosa* A. SCOTT, 1909, p. 62; *Undeuchaeta minor* WOLFENDEN, 1911; SARS, 1925, p. 79; FARRAN, 1926, p. 253; FARRAN, 1929, p. 233; WILSON, 1932, p. 61; *Undeuchaeta plumosa* FARRAN, 1936, p. 89; BRODSKY, 1950, p. 181.

Female. Length, 3.61 mm: cephalothorax, 2.80 mm; abdomen, 0.81 mm. Head fused with first thoracic segment; fourth and fifth thoracic segments fused. Lateral corners of last thoracic segment asymmetrical: left side is produced bluntly triangularly (fig. *a, b, c*). Rostrum short and stout, directs downwards.

Abdomen 4-segmented; segments and furca in the proportional lengths 45:24:20:2:9=100. Genital segment asymmetrical, carries a dorsal spine on the right margin about the middle, and a row of hairs on the distal corner; left lateral margin

has near the base a low protuberance or something like cement substance which runs posteriorly about to the two-thirds of the segment; the lateral distal corners of the segment are furnished with groups of short hairs. Second segment with spinules on the distal margin. Furcal rami 1.5-times as wide as long (fig. *c, d, e*).

First antenna 23-jointed, extends to distal end of genital segment; proportional lengths of joints as follows:

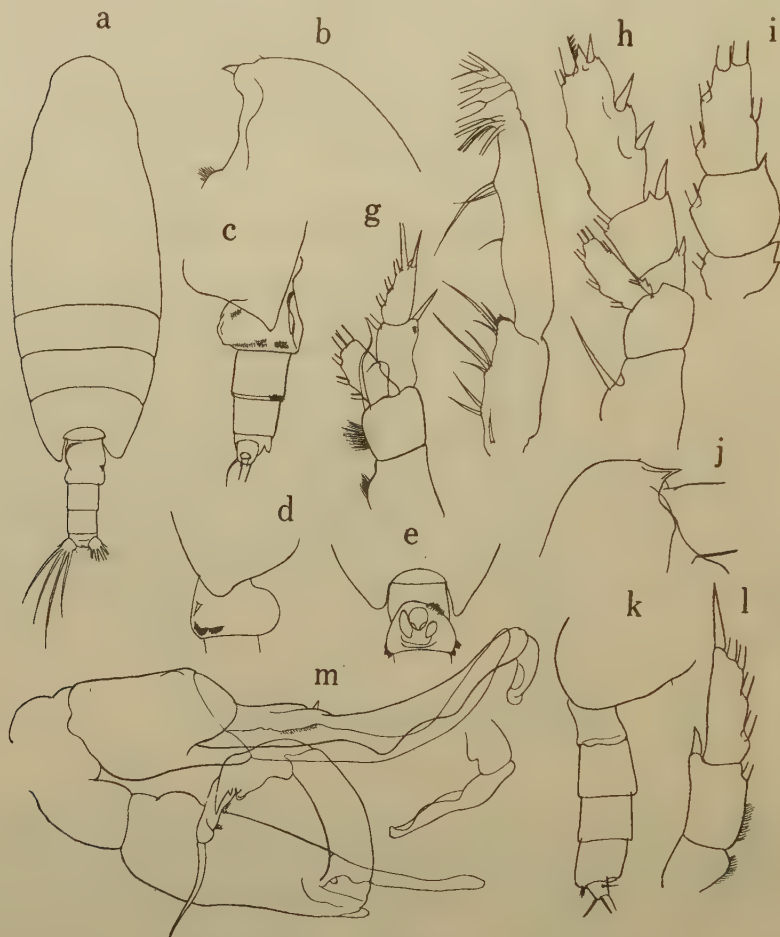


Fig. 58. *Undeuchaeta plumosa* (LUBBOCK).

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, last thoracic segment and genital segment, right side, lateral aspect; *e*, last thoracic segment and genital segment, ventral aspect; *f*, maxillipede; *g*, first leg; *h*, second leg; *i*, endopodite of fourth leg; *j*, Male: head, lateral aspect; *k*, last thoracic segment and abdomen, lateral aspect; *l*, exopodite of first leg; *m*, fifth pair of legs.

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	57	33	33	29	33	33	34	49	33	33	29	52	43	55	60	53
	18	19	20	21	22	23	24-25									
	49	60	52	43	43	49	49=1000;									

joint 17 is the longest; last two joints are of equal lengths. Second antenna with exopodite 2-times as long as endopodite. In first maxilla outer lobe has 9 setae, of which the proximal four are short; exopodite with 11 setae, of which 4 are longer. Second basal joint of maxilliped is about 2-times as long as the first; endopodite is half the length of first basal joint (fig. *f*).

In first leg first and second joints of exopodite fused (fig. *g*). Second leg with 1-jointed endopodite; outer edge spine on proximal margin of endopodite has an accessory tooth (fig. *h*). Third and fourth legs with 3-jointed endopodite (fig. *i*). Terminal spine of exopodite of second to fourth legs with 32, 26 and 26 teeth respectively.

Male. Length, 3.45 mm: Abdomen is contained 2.7-times in the length of cephalothorax. Lateral corners of last thoracic segment rounded (fig. *k*). Rostrum short, directs straight downwards (fig. *j*).

Abdomen 5-segmented; segments and furca in the proportional length 23:30:26:20:2:9=100. Anal segment is very short, and concealed beneath the fourth. Second and third segments are furnished with minute teeth on the posterior margin. Second furcal seta about 2-times as long as the others; appendicular seta very short.

First antenna 21-jointed, extends to distal end of last thoracic segment; articular menbranes faintly visible between joints 9 and 10, and between joints 12 and 13; joints are in the proportional lengths:

Joint	1	2	3	4	5	6	7	8-9-10	11	12-13	14	15	16	17
	73	43	22	23	26	30	33	73	30	73	40	45	55	60
	18	19	20	21	22	23	24-25							
	56	63	55	45	45	53	56=1000.							

Second antenna and the other mouth parts are not characteristic.

First leg with a short outer edge spine on second joint of exopodite (fig. *l*). In second leg outer marginal spine on second and third joints of exopodite are of equal lengths. Fifth pair of legs are very characteristic as shown in the figure: endopodite of left leg is about as long as first joint of exopodite; in right leg second basal joint is longer than first joint of the exopodite; third joint of exopodite is elongated (fig. *m*).

Occurrence. 27 females and 6 males from Sagami, and one female and one male from Suruga in the vertical hauls 1000-0 m, Nov. 1937.

Distribution. The species appears to be widely distributed in the oceans, and has been recorded from the Pacific, Atlantic and Malay Archipelago, but not from the Indian seas.

Undeuchaeta major GIESBRECHT(Fig. 59, *a-h*)

Undeuchaeta major GIESBRECHT, 1892, p. 227; ESTERLY, 1905, p. 148; FARRAN, 1905, p. 35; FARRAN, 1908, p. 37; A. SCOTT, 1909, p. 61; WOLFENDEN, 1911, p. 243; WITH, 1915, p. 136; SARS, 1925, p. 81; FARRAN, 1926, p. 254; FARRAN, 1929, p. 233; WILSON, 1932, p. 60; SEWELL, 1947, p. 104; BRODSKY, 1950, p. 182.

Female. Length, 4.43 mm: cephalothorax, 3.55 mm; abdomen, 0.88 mm. Head with a median crest (fig. *a*, *b*). Lateral corners of last thoracic segment asymmetrical:

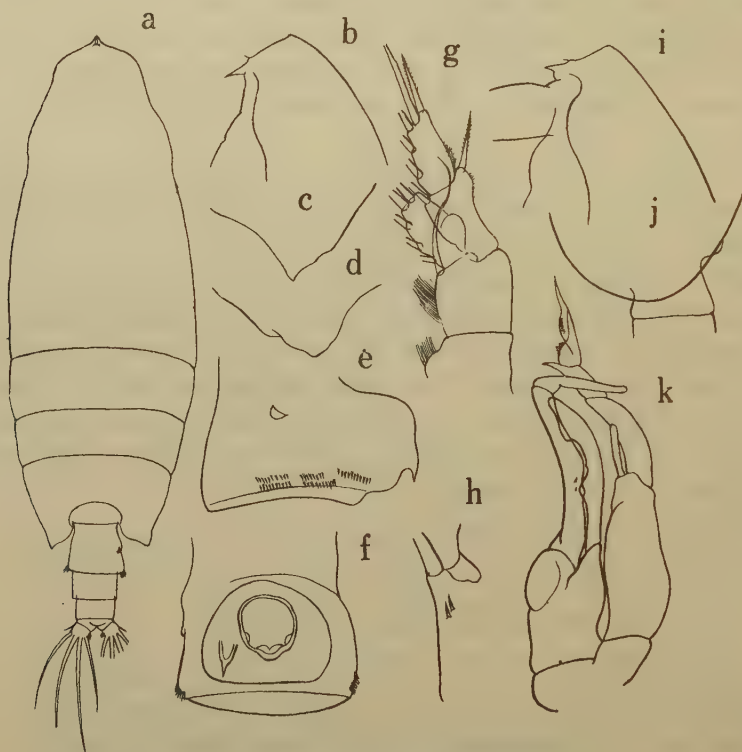


Fig. 59. *Undeuchaeta major* GIESBRECHT.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment, and abdomen, left side, lateral aspect; *d*, genital segment, right side, lateral aspect; *e*, genital segment, ventral aspect; *g*, first leg; *h*, inner margin of first basal joint of fourth leg; *i*, Male: head, lateral aspect; *j*, last thoracic segment, left side, lateral aspect; *k*, fifth pair of legs.

right side is not pointed at the apex (fig. *e*, *d*). Abdomen 4-segmented; segments and the furca in the proportional lengths 47:23:18:2:10=100. Genital segment asymmetrical: right side has a small protuberance on the lateral margin about the

middle; there is on ventral side of the segment a sharp spine near the genital opening (fig. *e, f*).

First antenna 23-jointed, extends to the end of second abdominal segment; proportional lengths of the joints are:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	61	45	27	27	31	31	31	49	27	32	28	49	45	56	61	65
	18	19	20	21	22	23	24-25									
	49	61	53	41	41	45	45=1000;									

joint 17 is more than 2-times as long as the 12th whereas, according to WITH, it is scarcely, not distinctly twice as long as the 12th=second antenna with exopodite about 1.7-times as long as endopodite. Mandible, maxillae as described by GIESBRECHT. Maxillipede has second basal joint 1.7-times as long as the first.

First leg as the description given by WITH (fig. *g*). Fourth leg with two small spines on posterior surface of first basal joint (fig. *h*).

Male. Length, 4.12 mm: cephalothorax, 3.06 mm, abdomen, 1.06 mm. Forehead with a median crest (fig. *i*). Lateral corners of last thoracic segment rounded (fig. *j*). Abdominal segments and furca in the proportional lengths 18:28:23:20:3:8=100. Furcal rami as long as wide. First antenna 21-jointed, extends to distal end of second abdominal segment. Fifth pair of legs resemble those of *Undeuchaeta plumosa*; endopodite of left leg is shorter than first joint of exopodite of the same leg (fig. *k*).

Occurrence. Four females and two males from Sagami, Nov. 1937 in the hauls 1000-0 m.

Distribution. The species is widely distributed in the Pacific, Atlantic and Malayan region.

Undeuchaeta magna sp. nov.

(Fig. 60, *a-f*)

Female. Length, 6.07 mm: cephalothorax, 4.89 mm, abdomen, 1.18 mm; abdomen is contained 4.1-times in the length of cephalothorax. Head distinctly separates from first thoracic segment; fourth and fifth thoracic segments are fused (fig. *a*). Forehead with a median crest. Rostrum one-pointed, short, and broad at the base in lateral view (fig. *b*). Last thoracic segment slightly asymmetrical: left side is triangularly produced, and pointed at the apex; right side is irregularly rounded, with a small prominence on the postero-lateral corner (fig. *c*).

Abdominal segments and furca in the proportional lengths 41:21:21:5:12=100. Genital segment has a protuberance which is much larger than that of *U. major*; ventral spine near genital opening is smaller than that of *U. major* (fig. *c, d, e*). Furcal rami longer than wide.

First antenna extends to the end of furca; joints are in the proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	61	52	30	30	30	33	33	46	31	31	31	46	40	55	61	67
	18	19	20	21	22	23	24-25									
	46	61	52	38	42	44	42=1000.									

Mouth appendages as those of the foregoing species.

Swimming legs not so characteristic. First leg as shown in the figure (fig. *f*). Terminal spine of exopodite of second to fourth legs with 40, 32 and 33 teeth respectively. Spinules on the posterior surface of second basal joint of fourth leg absent (fig. *g*).

Remarks. The present specimen, though closely resembles *U. superba* WITH, is distinguished from it in the shape of crest, lateral process of genital segment, and

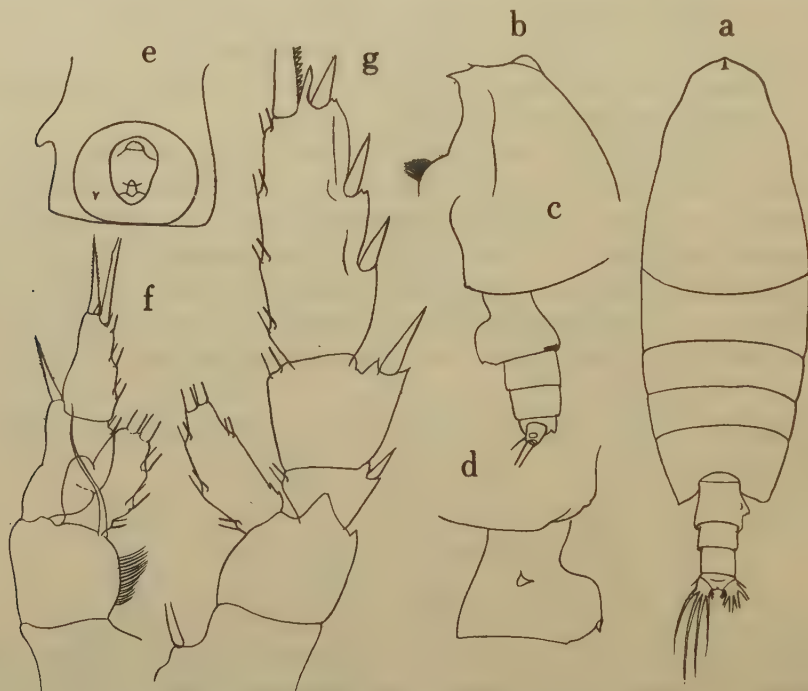


Fig. 60. *Undeuchaeta magna* sp. nov.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, last thoracic segment and genital segment, left side, lateral aspect; *e*, genital segment, ventral aspect; *f*, first leg; *g*, second leg.

absence of the teeth on second basal joint of fourth leg.

Occurrence. One adult female from Suruga in the haul 1000-0 m, July, 1937.

Genus *Valdiviella* STEUER, 1904

Six species of this genus, *Valdiviella brevicornis* SARS, *V. insignis* FARRAN, *V.*

ignota SEWELL, *V. minor* WOLFENDEN, *V. oligarthra* STEUER and *V. gigas* (BRADY), have been reported from the Indian seas by SEWELL, one of which *V. oligarthra* was found in the collection. The genus *Valdiviella* was created by STEUER to accommodate a new species which is closely related to *Euchaeta* PHILLIPI, and also to some genera of Aetidaeidae. According to STEUER the genus has the mandible similar in structure to those of *Gaetanus* and *Chiridius*; first maxilla as in *Undeuchaeta*; second maxilla as in *Aetideus*. The genus *Valdiviella* is regarded as a member of the family Aetidaeidae, whereas SARS and A. SCOTT have classed it in the family Euchaetidae. A. SCOTT states "the genus is closely related to *Euchaeta*, but easily recognised by its bifurcate rostrum; the incomplete jointing of the exopodites of the first and second pairs of feet, and indistinctly 3-jointed endopodites of the third and fourth pair of feet are the characters of this genus." He does not mention about the systematic position of the genus. The genus has the following characters: general appearance as in *Euchaeta*; head and first thoracic segments are fused; fourth and fifth thoracic segments are fused; posterior margins of last thoracic segment are rounded; the abdomen 4-jointed; appendicular seta short; endopodite of second antenna about as long as exopodite; endopodite of mandible about as long as exopodite; first maxilla differs from that of *Euchaeta*: setae on the endopodite and second basal joint much reduced; endopodite has only three, second basal has three setae, whereas that of *Euchaeta* has 3+3+3 setae on endopodite, and five on second basal; second maxilla resembles that of *Aetideus*, setae on fifth lobe strong; maxillipede resembles that of *Undeuchaeta* and *Euchaeta*, but row of spinules on the anterior margin of second basal joint are situated on the proximal half, whereas, it is on the distal half in *Euchaeta*, and they are feeble. First leg as in *Euchirella*: first and second joints of the exopodite are fused; endopodite of second leg one-jointed, that of third leg 2-jointed; fourth leg has 3-jointed exopodite and endopodite; fifth pair of legs absent in female; male fifth pair of legs resemble those of *Chirundina*. The genus has a closer relationship to Aetidaeidae in the followings: rostrum resembles that of *Aetideopsis* or *Undinopsis* in its bifurcate form; maxilla has the reduced number of setae on endopodite and on second basal; second maxilla as those of *Aetideus* in having a strong seta on fifth lobe; first legs are similar to those of *Euchirella*; second leg also as in *Euchirella* or *Undeuchaeta*. The genus has resemblance to *Euchaeta* in the followings: general appearance, and the structure of first antenna, mandible and maxillipede. Thus the genus *Valdiviella* has the generic characters which are in common both to Aetidaeidae and Euchaetidae. It is the intermediate form between *Undeuchaeta* and *Euchaeta*. It seems reasonable, at present, as STEUER stated, to accommodate it in the Family Aetidaeidae.

Valdiviella oligarthra STEUER

(Fig. 61, a-g)

Valdiviella oligarthra STEUER, 1904, p. 593; WOLFENDEN, 1911, p. 247; SEWELL, 1929, p. 140.

Female. Length, 9.57 mm: cephalothorax, 6.38 mm; abdomen, 3/19 mm. Cephalothorax oval; head separates incompletely from first thoracic segment; fourth and fifth thoracic segments are fused (fig. *a*). Lateral corners of last thoracic segment rounded (fig. *b*). Rostrum two-pointed, and short; frontal prominence low (fig. *b*). Abdomen 4-jointed; it is contained 2-times in the length of cephalothorax; segments and furca in the proportional lengths 40:23:19:8:10=100. Genital area indented in lateral view; second and third segments are each furnished with a tuft of hairs on the

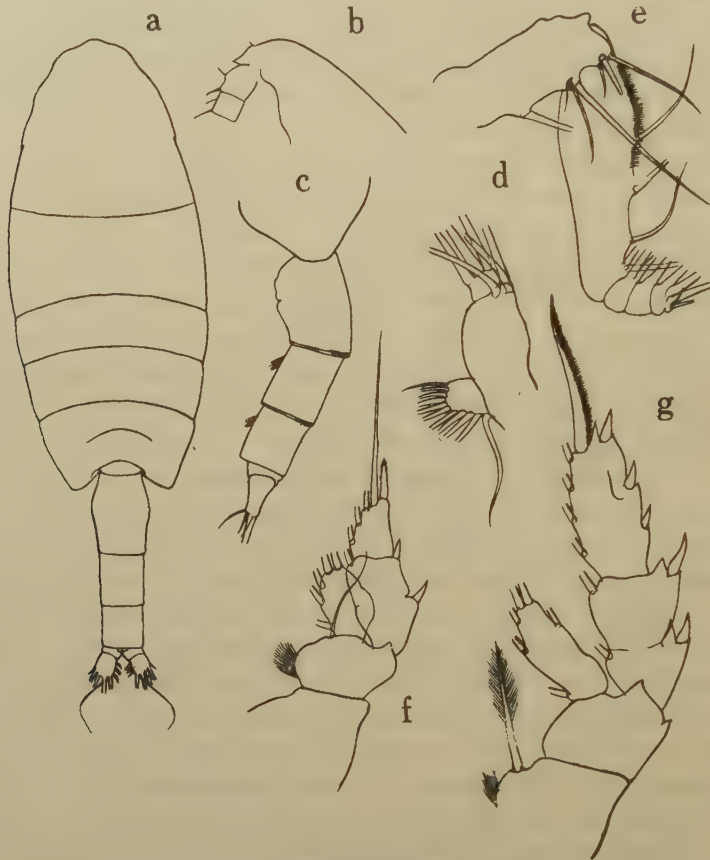


Fig. 61. *Valdiviella oligarthra* STEUER.

a, Female: dorsal aspect; *b*, head, lateral aspect; *c*, last thoracic segment and abdomen, lateral aspect; *d*, exopodite and endopodite of first maxilla; *e*, maxillipede; *f*, first leg; *g*, second leg.

ventral side near the proximal margin; first three segments are fringed with fine teeth on the distal margin (fig. *c*). Furcal rami as long as wide.

First antenna 23-jointed, extends to distal end of third thoracic segment when

pressed against the body; joints are in the following proportional lengths:

Joint	1	2	3	4	5	6	7	8-9	10	11	12	13	14	15	16	17
	49	42	33	39	45	45	36	42	10	13	16	27	27	42	59	65
	18	19	20	21	22	23	24-25									
	45	72	65	52	45	52	59=1000.									

Second antenna and the other mouth parts as described in the generic character. Maxillipede as shown in the figure (fig. *e*).

First leg has 2-jointed exopodite and one-jointed endopodite (fig. *f*). Second to fourth legs have each 2-jointed exopodite; viz. joint 1 and 2 of exopodite are fused; endopodite of second leg one-jointed (fig. *g*); those of third and fourth legs 2-jointed.

Remarks. The specimen agrees well with *V. oligarthra*, in having short first antenna, and 2-jointed exopodite in first to fourth legs. In *V. brevicornis* first and second joints of exopodite of first to fourth legs are separate. The specimen from the Indian seas measured 7.2 mm in the female.

Occurrence. One adult female from Suruga in a haul 1000-0 m, Nov. 1938.

Distribution. The species has been recorded only from the Atlantic and Indian Oceans.

